

A REVISION OF THE ROTATORIAN GENERA LEPADELLA
AND LOPHOCHARIS WITH DESCRIPTIONS OF FIVE NEW
SPECIES.

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INTRODUCTION.

In the following pages an attempt has been made at a revision of the Rotatoria that have been gradually accumulating under the generic name *Metopidia*. Adequate descriptions exist only in the case of a few strikingly marked species, and the majority are decidedly unobtrusive in appearance, so that the group is now in a very confused condition. This is not entirely of recent origin, but dates back in part at least to Ehrenberg. He seems to have been temporarily under the ascendancy of Schelling's Naturphilosophie and the circular, quinarian and other vagaries of Oken, who was trying by abstract speculation to discover the simple and perfectly logical system pervading all nature; the facts, when found, were bound to fit the theory. This influence is very evident in the highly artificial classification proposed by Ehrenberg in his paper read before the Berlin Academy in 1850.

While Ehrenberg gradually drifted away from this system, he never rescued the Lepadellids, the one group that, more than any other, had suffered from it. We find, therefore, in his Infusions-thierehen of 1838 a total of four species belonging to this genus under seven specific names, one animal being allotted no less than four specific and three generic names, founded on the supposed number of eyespots; none, two or four. That all the Lepadellids have two eyespots, and two only, was demonstrated long ago, and it is in no case accepted as a generic character. Dujardin, in 1841, united these supposed species in one genus, *Lepadella*, and attempted to reduce their number, but his first-hand knowledge of the animals appears to have been rather limited and his work is probably in this instance simply compilation. Gosse, in *The Rotifera*, followed his example and left the species in a single genus, applying to it the name *Metopidia*, the most recent one of those proposed up to that time. His treatment of the different species is a great improvement

over that of Ehrenberg, but his achievement was partly nullified by Hudson in the Supplement, where all the Ehrenbergian names are rehabilitated.

In dealing with the Rotatoria grouped under the name *Metopidia* by Hudson and Gosse it is necessary to separate them into two genera, *Lepadella* and *Lophocharis*, as proposed by Iroso in a recent paper. This division was suggested by Ehrenberg in 1838,¹ but for convenience he left the only then known species of *Lophocharis* in the genus *Lepadella*. The anatomy of the two genera differs in so many important points that no serious objection can be urged against their separation. *Lepadella* is without doubt descended from forms that until comparatively recent times did not have the integument stiffened into a lorica except on the dorsal surface. If additional evidence were needed on this point, it is furnished by the closely related genus *Colurella* (= *Colurus*), which even today is without a ventral plate; it is true that the edges of the dorsal plate have in this case curved toward each other, so as to leave only a narrow ventral slit unprotected by the lorica, thus accomplishing the same object in a different way, but the history of the development of the lorica is obvious. *Lophocharis*, on the contrary, has a box-like lorica, which shows no evidence of having passed through the *Colurella*-stage, and it is highly probable that the lorica was developed gradually and simultaneously over the entire surface of the body. The peculiar structure of the posterior end of the body in the Lepadellids, with the foot projecting through the ventral plate at the anterior end of a "foot groove," occupying about one-third of the length of the ventral plate, is totally absent in *Lophocharis*, and so is the protective dorsal hood over the corona. The Lepadellids have two frontal eyespots, while *Lophocharis* has, according to Iroso, a single eyespot on the ganglion.

While both genera belong to the group centering about the genus *Euchlanis*, they must be assigned to different branches of it. *Lepadella* (with *Colurella*) appears to be more nearly related to the genus *Euchlanis* than to any other, while *Lophocharis* belongs to a small group typified by the genus *Trichotria* (= *Dinocharis*). This group also includes *Macrochaetus* (= *Polychaetus*) and *Wolga* Skorikov, the last-named genus with the single species *W. spinifera* (= *Distyla spinifera* Western), which is in no way related to the genus *Lecane* (including the genera *Cathypna* Gosse and *Distyla* Eckstein, not of Eichwald), as it is without any of the generic characters of typical Lecanids.

As a rule no localities have been given for the species considered in this paper. Two reasons may be advanced for this omission. The more easily recognized species, which may with a fair degree

¹ Infusionsthierchen, p. 438.

of certainty be accepted as correctly determined, appear to be found the world over, wherever collections are made in suitable localities, and the relatively small number of existing records are consequently of little significance. As for the more critical species, on account of the lack of precision in the original descriptions, from which the determinations were made, it is usually quite uncertain what the investigator who recorded them may have been dealing with, and a repetition of such references would be of no assistance in attempts to ascertain the geographic range of the species. It is the hope of the writer that this paper may simplify the task of identifying these small forms and thus contribute to a solution of the problems of distribution. Of the species here described there are at least 8, and possibly 10, that have not as yet been reported from Europe; whether they will eventually be found there also, or whether an equal number of non-American forms will be discovered, remains to be seen. However, the latter contingency appears rather remote, as the genus has all the earmarks of being a very ancient one, which long ago became so highly specialized as to preclude any further evolution or local species-formation and therefore devoted its energies to dispersion.

All the species described have been studied from fully contracted specimens, as the anterior margin offers some of the most important characteristics. In order to avoid needless multiplication of plates and to indicate the limits of variation the dorsal and ventral views have been drawn from different specimens. For some highly variable species this was insufficient and enough figures have been added to show at least the principal forms likely to be met with.

For the illustrations the sliding scale used by the writer in two earlier papers has been employed. An animal measuring $100\ \mu$ is represented by a figure 50 mm. long and for each succeeding $100\ \mu$ an addition of 10 mm. is made. This method is a compromise and as such is of course open to objections, but it gives at least a system. The uniform magnification used by some writers is objectionable in that either the small species must be figured so very small as to make it impossible to give the necessary detail, or else the large forms reach impracticable dimensions. A uniform magnification seems, moreover, comparatively meaningless; when natural size is once discarded, the extent of the departure is of minor importance. In the study of the animals a magnification suited to the object is employed and actual measurements obtained by means of the micrometer. The sliding scale has the advantage of not reducing the smallest species below the point where details may be satisfactorily shown, while the largest known rotifer may be figured on an octavo page and at the same time some indication of the comparative size is given.

Among the important causes of the present confusion in the Lepadellids, allowance must be made for the variability of some of the species, notably of *Lepadella patella* (Müller) and *L. ovalis* (Müller); intimately connected with this is the fact that material from a sufficiently large territory to ascertain the limits of these variations has not been at the command of any one investigator. The writer has been very fortunate in having access to an abundance of collections, without which this work would have been impossible.

Through the kind intervention of Dr. Chancey Juday, of the University of Wisconsin, to whom I am specially indebted, as well as to Dr. E. A. Birge, director of the Wisconsin Geological and Natural History Survey, I have had the use of the following material from the all but inexhaustible storehouse of the Survey:

Collections by Doctor Birge during the Great Lakes Investigations by the United States Fish Commission in 1899.

Collections from Texas, Louisiana, Arkansas, and Missouri, by Doctor Birge and Doctor Juday in 1903.

Collections from the Finger Lakes in New York, by Doctor Birge and Doctor Juday in 1910.

Collections from Washington, Oregon, Idaho, and California by Mr. W. Boormann, of the University of Wisconsin, in 1910.

Collections from Mexico, Guatemala, Salvador, and Nicaragua by Doctor Juday in 1910.

Collections from various points in Alaska by Mr. G. Dallas Hanna in 1905.

Collections by Mr. J. M. Jessup in 1911 and 1912 along the boundary line between Alaska and Canada from the Porcupine River to the Arctic Ocean.

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It is a great pleasure to express my gratitude to these gentlemen, as any value which this work may have is principally due to their kind assistance; with only local material for study, the writer would have been no better off than earlier investigators working also on collections from a limited territory and would no doubt have encountered the same pitfalls.

The species listed below have been omitted from the specific descriptions, as they are unknown to the writer. Some appear to be insufficiently described for identification and others were probably incorrectly referred to the genera which form the subject of this paper.

Lepadella mucronata SCHMARDA, Neue wirbell. Thiere, vol. 1, pt. 1, 1859, p. 57, pl. 13, fig. 120.

Lepadella setifera SCHMARDA, Neue wirbell. Thiere, vol. 1, pt. 1, 1859, p. 58, pl. 13, fig. 121.

Lepadella vitrea (SHEPHARD).

Metopidia ovalis ANDERSON and SHEPHARD, Proc. Royal Soc. Victoria, n. ser., vol. 4, 1892, p. 78, pl. 12, fig. 6.

Metopidia vitrea SHEPHARD, Proc. Royal Soc. Victoria, n. ser., vol. 24, 1911, p. 55.

Lepadella vitrea HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 65.

Lophocharis rostrata EICHWALD, Bull. Soc. Imp. Nat. Moscou, vol. 22, 1849, pt. 1, p. 536, pl. 4, fig. 27.

Lophocharis triangulum EICHWALD, Bull. Soc. Imp. Nat. Moscou, vol. 17, 1844, pt. 2, p. 680.

Metopidia pygmaea GOSSE, Journ. Royal Micr. Soc., 1887, p. 867, pl. 15, fig. 17.—HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 46, pl. 31, fig. 47.

Metopidia scutumipes MOLA, Zool. Anz., vol. 42, 1913, p. 124, text fig.; Ann. Biol. Lacustre, vol. 6, 1913, p. 271.

Genus LEPADELLA Bory de St. Vincent.

Lepadella BORY DE ST. VINCENT, Class. Anim. Micr., 1826, p. 44. Type (by designation of Haring, Bull. 81 U. S. Nat. Mus., 1913, p. 63), *Lepadella patella* (Müller)=*Brachionus patella* Müller.

Metopidia EHRENBERG, Abh. Akad. Wiss., Berlin, 1830, p. 72. Type (monotype): *Metopidia triptera* Ehrenberg.

The genus *Lepadella* was proposed by Bory de St. Vincent in his Essai d'une classification des animaux microscopiques, 1826, for *Brachionus patella* Müller, to which were doubtfully added *Trichoda cornuta* Müller and *Brachionus lamellaris* Müller. When the question of type designation was before the writer, it seemed that *Brachionus patella* was the logical choice, this being the only species definitely designated as a member of the genus *Lepadella*, which was accepted by Ehrenberg and Dujardin in substantially the same sense; moreover, Müller's figure is as good as many of the much more recent picto-

rial representations of this animal. Depending as usual for generic distinction upon the number of eyespots, in this case incorrectly observed, Ehrenberg added a new generic name, *Metopidia*, and made use also of Bory de St. Vincent's *Squamella*, which was originally proposed for *Brachionus bractea* Müller, a *Euchlanis* species, probably *E. dilatata*. Dujardin reduced these three genera to one, retaining the name *Lepadella*; as this is the oldest available name, it has been used here in preference to *Metopidia*, the generic designation employed by Hudson and Gosse. It should be borne in mind that the types are different, and *Metopidia* may at some future date be revived, when a subdivision of the present genus becomes necessary. With the comparatively small number of species now known, there is no occasion for a division among such closely related forms.

The Lepadellids are a group of uniformly small plioimate Rotatoria related to the Euchlanids and characterized by the peculiar structure of the lorica. While without any actual division, it is convenient to describe the lorica as composed of a dorsal and a ventral plate, rigidly united at the edges. This also serves as a reminder of the probable development of the lorica, as noted in the introduction; it seems evident that the Lepadellids are descended from ancestors protected only by a firm dorsal plate, the ventral integument being flexible, with the suture where we now find the edge of the lorica. On this assumption only is the structure of the Lepadellid lorica in its present form intelligible.

The lorica has at the anterior end an opening for the protrusion of the head and on the ventral surface, some distance from the posterior end, there is a perforation through which the foot projects. The outline of the lorica is usually ovate; in some species it is provided with lateral spurs or wing-like extensions, giving it a rhomboid or trianguloid appearance. The cross section of the body in the typical group is a segment of a circle, of varying height; in the *Metopidia*-group it is triradiate, in various degrees of development. The dorsal plate has near its posterior end two openings for the lateral antennae; these are indicated in the figures, but, as their position is so nearly uniform in the genus, no mention has been made of them in the descriptions.

The anterior opening of the lorica is usually supplemented by a dorsal sinus of moderate depth and a relatively large ventral sinus is always present. To give additional room for the free movement of the head the ventral plate curves downward around the anterior opening. In reading the descriptions of the dorsal and ventral sinus the fact that the animals are not flat must be kept in mind; what is actually seen is a projection on a plane of a structure with appreciable depth, as will be realized from the lateral views, and the anterior points shown in the dorsal and ventral views are in

some instances really broad, rounded lobes. Nearly all the species have a collar of some sort around the anterior opening; this may be only a beadlike thickening of the edge of the lorica, or it may take the form of a coarsely stippled area limited posteriorly by a faint line. This stippled collar is usually narrowest on the median line and increases in width toward the edges of the lorica; the stippling is coarsest near the middle of the collar and disappears gradually as the width becomes greater.

The foot projects through an opening in the ventral plate, about two-thirds the length of the lorica from the anterior end, and at the bottom of a nearly parallel-sided groove, semicircular in section, which is here called the foot groove. The body projects slightly through the foot opening, forming the base of the three-jointed foot, which bears two slender toes, about one third the length of the lorica. While no doubt good reasons could be advanced for considering the foot four-jointed, it seems natural to apply the term "joint" only to the three posterior segments of the foot, as the basal segment is not mobile. Moreover, the "foot," as this term is applied to Rotatoria, is in no case anything but a mere convention for the posterior reduced portion of the body and the starting point is consequently also conventional and not founded upon any morphological distinction.

On the dorsal side of the terminal foot joint there is a circular depression with a small rounded papilla in the center. This is here called a sensory pit. Whether this is really the true significance of this structure can not be definitely established, but it is at least not improbable, reasoning from analogous organs in other genera. The rounded papilla appears to have a central marking, but no sensory setae have been found on it, in spite of careful search. This sensory pit has not been demonstrated in all the species, but has been found in all cases where it was possible to obtain a properly oriented view under a sufficiently high magnification.

No detailed study has been made of the corona and the trophi in the different species of the genus, but *Lepadella benjamini* may serve as an example, especially as these organs apparently vary but little in this genus. The corona, plate 93, figures 5 and 6, is a typical *Euchlanis*-corona with the dorsal arc of cilia suppressed on account of the protective dorsal hood. In *Euchlanis* the head is protected by three plates—one dorsal and two lateral—none of which projects far enough to interfere with the free movement of the coronal cilia. In *Lecane* and *Monostyla* various stages of the progressive development of the dorsal segment of this head covering are to be found; in *Monostyla galeata* Bryce it reaches almost the extreme specialization of the Lepadellids. The buccal plate is covered with very short cilia and the mouth is at its lower extremity; the lateral arcs are

moderately developed and probably serve to direct the food to the mouth rather than as organs of locomotion. As such the lateral portions of the circumapical band have become specialized, recalling the auricles of the Notommatids. The trophi, plate 93, figures 7 and 8, are typically malleate, only differing in the large transverse crutch at the end of the fulcrum. The basal apophyse or, probably more correctly, the first transverse ridge, of the rami is very large and evidently specialized for the attachment of the abductor muscles. The unci are five-toothed, the slightly clavate teeth resting in the depressions between the ridges of the rami.

The males of the Lepadellids are very rarely found; Wesché has described¹ the male of *Lepadella ovalis* (Müller) (= *Metopidia solidus* Gosse). It is of the usual degenerate type and in appearance almost identical with the male of *L. patella* (Müller), plate 91, figures 1 and 2.

The majority of the species belonging to this genus vary between rather wide extremes; the variations are, however, heritable, in contradistinction to the cyclic, seasonal or ecologic variations exhibited by many Rotatoria. Consequently we find each species broken up into a number of local races, varying but little individually, so that, in order to establish the limits, it is not sufficient to examine the form which happens to exist in a circumscribed territory, but it is important to have material from the greatest possible number of stations. It will readily be understood from this, that when some rare species, of which the description given here is based on material from one or two collections, is found elsewhere, it is quite likely to possess a number of peculiarities. The most reliable characteristics are the relative longitudinal dimensions, such as the depth of the dorsal and ventral sinus, the length of the foot groove, foot and its terminal joint, and, finally, the length of the toes. Proportional measurements given in the text have therefore been referred to the length of the lorica. Transverse measurements, such as the width of the lorica, anterior opening and the width of the foot groove are all subject to considerable variation and therefore rather unreliable.

The genus seems naturally divisible into two groups, a Lepadella-group, having a convex dorsal plate without any median keel, and a Metopidia-group with a dorsal keel, making the cross section of the body triradiate or trialate. The Lepadella-group would under this arrangement be composed of the following species: *Lepadella apsidea*, new species, *L. ovalis* (Müller), *L. patella* (Müller), *L. latusinus* (Hilgendorf), *L. amphitropis*, new species, *L. quinquecostata* (Lucks), *L. cryphaea*, new species, *L. acuminata* (Ehrenberg), *L. dactyliseta* (Stenroos), *Lepadella benjamini*, new species, *L. cyrtopus* Harring,

¹ Journ. Quekett Micr. Club, ser. 2, vol. 8, p. 123.

L. bidentata Voronkov, *L. borealis*, new species, *L. heterostyla* (Murray), *L. ehrenbergii* (Perty), and *L. pterygoïda* (Dunlop). To the Metopidia-group must be referred: *Lepadella imbricata* Harring, *L. rhomboides* (Gosse), *L. cristata* (Rousselet), *L. rhomboidula* (Bryce), *L. triptera* Ehrenberg. The lateral projections of *L. ehrenbergii* and *pterygoïda* are probably of specific value only, as may be inferred from the variations of *L. latusinus*. In extreme cases this has lateral spurs rivalling in size those of *L. ehrenbergii*, and yet furnishes a complete series of forms limited at the other extreme by a variety with a posterior emargination differing but little from that of *L. ovalis*. The same is apparently true of the longitudinal ridges developed in a number of species, conspicuously so in *L. quinquecostata* and *pterygoïda*. If this peculiarity really possessed any generic or subgeneric value, these two species would be expected to possess other characteristics in common; as a matter of fact they agree only in the generic characters.

KEY TO THE GENUS LEPADILLA.

1. Dorsal plate convex, without prominent median ridge2.
Dorsal plate with prominent median ridge, body triradiate in cross section ...17.
2. With distinct anterior dorsal sinus3.
Without distinct anterior dorsal sinus13.
3. Depth of anterior dorsal sinus less than 1/2 width4.
Depth of anterior dorsal sinus more than 1/2 width9.
4. Toes equal5.
Toes unequal8.
5. Toes fused at base13. *borealis*, new species.
Toes not fused at base6.
6. Lorica with two prominent dorsal ribs and two curved lateral projections.
16. *pterygoïda* (Dunlop).
Lorica without prominent dorsal ribs7.
7. Foot groove very wide4. *latusinus* (Hilgendorf).
Foot groove not very wide, a median ridge on dorsal and ventral plate.
5. *amphitropis*, new species.
8. Lorica rhomboid, edges upturned anteriorly14. *heterostyla* (Murray).
Lorica with two curved lateral projections, edges not upturned.
15. *ehrenbergii* (Perty).
9. Lorica rounded posteriorly10.
Lorica with a posterior point12.
10. Dorsal plate with longitudinal ridges6. *quinquecostata* (Lucks).
Dorsal plate without longitudinal ridges12.
11. Lorica strongly depressed2. *ovalis* (Müller).
Lorica not strongly depressed3. *patella* (Müller).
12. Posterior point with basal inangulation7. *cryphaea*, new species.
Posterior point without basal inangulation8. *acuminata* (Ehrenberg).
13. Toes equal14.
Toes unequal11. *cyrtopus* Harring.
14. Posterior margin with a median lobe between two small spines.
12. *bidentata* Voronkov.
Posterior margin rounded, without spines15.
15. Anterior dorsal margin slightly concave10. *benjamini*, new species.
Anterior dorsal margin slightly convex16.

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|---|-----------------------------------|
| 16. Foot groove very wide..... | 1. <i>apsida</i> , new species. |
| Foot groove very narrow..... | 9. <i>dactyliseta</i> (Stenroos). |
| 17. With a dorsal spine..... | 19. <i>cristata</i> (Rousselet). |
| Without dorsal spine..... | 18. |
| 18. With dorsal sinus..... | 18. <i>rhomboides</i> (Gosse). |
| Without dorsal sinus..... | 19. |
| 19. Lorica ovate..... | 17. <i>imbricata</i> Harring. |
| Lorica rhomboid or subcircular..... | 20. |
| 20. Keel of moderate height, anterior dorsal margin slightly concave. | 20. <i>rhomboidula</i> (Bryce). |
| Keel very high, anterior dorsal margin with a shallow notch between two convex lobes..... | 21. <i>triptera</i> Ehrenberg. |

1. LEPADELLA APSIDA, new species.

Plate 89, figs. 1-3.

The body of this small species is nearly circular in outline; the dorsal plate is moderately convex and its edges project slightly below the general level of the nearly flat ventral plate. The depth of the body is less than half the width of the lorica at its widest point.

The opening for the head is circular; there is consequently no dorsal sinus, but, on the contrary, the anterior dorsal margin is convex. In order to permit the free movement of the head the ventral plate projects downwards around the anterior sinus. No stippled collar is present, but there is a beadlike line around the posterior half of the ventral sinus and slightly removed from the edge; it does not follow a course parallel to the edge of the ventral sinus, but, as shown in the ventral view, forms roughly five sides of a regular octagon.

The foot groove is U-shaped and rounded anteriorly; its length is about one-third that of the lorica and the width slightly greater. There are no posterior spines or other projections at the junction of the lateral edges of the foot groove and the posterior margin of the lorica.

The foot is fairly stout and short, the joints increasing slightly in length from the basal to the posterior. The toes are very short, less than one-sixth the length of the lorica, and taper regularly to acute points. A sensory pit on the terminal joint has not been found; this may be partly or entirely accounted for by the difficulties of observation.

Total length, 84 μ ; length of lorica, 70 μ , width 60 μ ; length of head opening 20 μ , width 24 μ ; length of foot groove 22 μ , width 24 μ ; length of toes, 12 μ ; depth of body, 24 μ .

Type.—Cat. No. 16826, U.S.N.M., is from East Swamp, South Bass Island, Lake Erie; this species has also been found in collections from ponds in Audubon Park, New Orleans, Louisiana. The material was in both cases collected by Dr. E. A. Birge, of the University of Wisconsin.

Lepadella apsidea appears to be rare; only a few specimens were found in each collection. It does not bear any close resemblance to other members of the genus and is easy enough to identify when found, but this is a matter of some difficulty, as it shares with *L. triptera* the distinction of being the smallest Lepadellid, and it is, in addition, excessively transparent.

2. LEPADELLA OVALIS (Müller).

Plate 89, figs. 4-10.

Brachionus ovalis MÜLLER, Anim. Infus., 1786, p. 345, pl. 49, figs. 1-3.

Mytilina lepidura BORY de St. VINCENT, Class. Anim. Micr., 1826, p. 87=
Brachionus ovalis renamed.

Lepadella ovalis EHRENBERG, Abh. Akad. Wiss., Berlin, 1830, p. 85, pl. 7, fig. 4; Infusionsth., 1838, p. 457, pl. 57, fig. 1.

Metopidia lepadella EHRENBERG, Abh. Akad. Wiss., Berlin (for 1831), 1832, p. 136; Infusionsth., 1838, p. 477, pl. 59, fig. 10.—V. HOFSTEN, Ark. Zool., Stockholm, vol. 6, No. 1, 1909, p. 63, text figs., part.—DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 192, text fig., part.

Squamella oblonga EHRENBERG, Abh. Akad. Wiss., Berlin (for 1833), 1834, p. 220; Infusionsth., 1838, p. 480, pl. 59, fig. 17.

Squamella bractea EHRENBERG, Infusionsth., 1838, p. 480, pl. 59, fig. 16; not *Brachionus bractea* MÜLLER, 1786.

Lepadella oblonga DUJARDIN, Hist. Nat. Zooph., 1841, p. 633.

Lepadella rotundata DUJARDIN, Hist. Nat. Zooph., 1841, p. 633.

Metopidia solidus GOSSE, Ann. Mag. Nat. Hist., ser. 2, vol. 8, 1851, p. 201.—HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 106, pl. 25, fig. 11.—SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 326, pl. 7, fig. 22.—WEBER, Rev. Suisse Zool., vol. 5, 1898, p. 632, pl. 22, figs. 25-27.—WESCHÉ, Journ. Quekett Micr. Club, ser. 2, vol. 8, 1901, p. 124, text fig.; Journ. Quekett Micr. Club, ser. 2, vol. 8, 1902, p. 324, footnote, pl. 18, fig. 5d.—LIE-PETTERSEN, Tromsø Mus. Aarsh., vol. 33, 1911, p. 67, text figs.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 120, text fig.

?*Stephanops ovalis* SCHMARDA, Neue wirbell. Thiere, vol. 1, pt. 1, 1859, p. 60, pl. 14, fig. 127.

Hexasemma melanoglena SCHMARDA, Neue wirbell. Thiere, vol. 1, pt. 1, 1859, p. 60, pl. 14, fig. 129.

Metopidia ovalis HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 46, pl. 34, fig. 2.

Metopidia torquata ANDERSON, Journ. Asiatic Soc. Bengal, vol. 58, 1889, pt. 2, p. 356, pl. 21, fig. 9.

?*Metopidia bractea* IROSO, Atti R. Ist. Incorr. Napoli, vol. 64 (for 1912), 1913, p. 475; not *Brachionus bractea* Müller, 1786.

Lepadella solidus HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 549.

The outline of the lorica varies from the broadly ovate form shown in figure 6 to subcircular, as figure 10; its width is but little less than the length. The dorsal plate is only slightly convex and, as the ventral plate is nearly flat, the actual volume of the body is quite small; the dorso-ventral depth is about one-fifth of the length of the lorica. The two plates are joined for some distance from the edge and the internal termination of this border is slightly irregular and minutely crenulate, the "milled edge" of Gosse.

The width of the anterior margin is one-fifth the length of the lorica. The dorsal sinus is U-shaped with slightly convergent sides; its depth is two-thirds of the width. The ventral sinus is very large and subrhomboid in outline, its widest point being some distance from the front; the depth is equal to the width of the anterior margin. The ventral plate curves strongly downward around the anterior sinus in order to give greater freedom to the movements of the head. A stippled collar is present on both dorsal and ventral plate.

The foot groove varies from the wide, nearly parallel-sided outline of figure 5 to the narrower, ovate form shown in figures 4 and 9; its length is equal to one-fifth of the length of the body. The edges of the groove project below the surface of the main portion of the ventral plate, at least posteriorly, as low ridges, occasionally forming obtuse points on each side of the posterior emargination.

The foot is stout and projects beyond the lorica; it is one-fifth the length of the body; the terminal joint is half the length of the entire foot. The toes are unusually short, about one-sixth the length of the lorica, tapering and slightly decurved. There is a sensory pit on the dorsal side of the last foot joint.

Total length, 190 μ ; length of lorica 155 μ , width 120–130 μ ; width of anterior margin, 25–32 μ ; depth of dorsal sinus, 20 μ ; depth of ventral sinus 30–35 μ , width 30–32 μ ; length of foot groove 42–45 μ , greatest width 30 μ , posterior width, minimum, 18 μ ; length of foot 38 μ , of terminal joint 18 μ ; length of toes, 32 μ ; depth of body, 30 μ . Figure 4 represents a small variety found near Atlantic City, New Jersey. Its dimensions are: Total length, 148 μ ; length of lorica 120 μ , width 96 μ ; width of anterior margin, 24 μ ; depth of dorsal sinus, 14 μ ; depth of ventral sinus 27 μ , width 27 μ ; length of foot groove 36 μ , greatest width 24 μ , posterior width 12 μ ; length of foot, 30 μ , terminal joint, 15 μ ; length of toes, 22 μ ; depth of body, 25 μ .

Lepadella ovalis is easily recognizable by its large size and the strongly depressed lorica, as well as by the relatively small opening for the head and the very short toes. While this species is quite variable, the variations are between the races found in different localities rather than between the individuals found in any one locality, so that in order to obtain the entire range of intermediate forms it is necessary to examine specimens from as many stations as possible. The narrow form illustrated by figures 5 to 8 is the one occurring at Washington; the nearly circular variant of figures 9 and 10 is from Yellowstone Park, Wyoming; the small form, figure 4, is, as noted above, from Atlantic City, New Jersey. The species is common in weedy ponds the world over.

In the study of the Ehrenbergian species greater dependence has been placed upon his figures than on the measurements given in the

text, as these are frequently unreliable and at times impossible, the length of *Lepadella emarginata*, for instance, being given as $\frac{1}{48}$ line, or 46 μ . His figures of the species here concerned are all stated to be drawn to a uniform magnification of 300 diameters, and with this as a guide, as well as the work of subsequent investigators, there can be little doubt of their identity. Müller's figure of *Brachionus ovalis* is not especially good, but the same criticism applies to a great many of the more recent illustrations and, as the name was accepted by Ehrenberg, there appears to be no reason for rejecting it now.

3. LEPADELLA PATELLA (Müller).

Plate 90, figs. 1-12.

Brachionus patella MÜLLER, Verm. Terr. Fluv., vol. 1, pt. 1, 1773, p. 130; Anim. Infus., 1786, p. 341, pl. 48, figs. 15-19.—SCHRANK, Fauna Boica, vol. 3, pt. 2, 1803, p. 132.

Lepadella patella BORY de St. VINCENT, Class. Anim. Micr., 1826, p. 86.

Lepadella emarginata EHRENBERG, Hemprich and Ehrenberg, Symb. Phys. Anim. Evert., 1831 (?1832), Phytozoa, fol. d (third page), pl. 2, Sinaitica, fig. 19; Infusionsth., 1838, p. 458, pl. 57, fig. 2.

?*Squamella quadridentata* SCHMARDA, Neue wirbell. Thiere, vol. 1, pt. 1, 1859, p. 60, pl. 14, fig. 128.

Squamella bractea ECKSTEIN, Zeitschr. wiss. Zool., vol. 39, 1883, p. 388.—FRANCÉ, Term. Füz., vol. 17, 1894, pp. 121, 176, pl. 6; not *Brachionus bractea* Müller, 1786.

Squamella oblonga ECKSTEIN, Zeitschr. wiss. Zool., vol. 39, 1883, p. 391; not of Ehrenberg, 1834.

Metopidia lepadella HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 106, pl. 25, fig. 6.—PLATE, Jenaische Zeitschr. Naturw., vol. 19, 1886, p. 59.—TESSIN, Arch. Naturg. Mecklenburg, vol. 43, 1890, p. 160, pl. 2, fig. 18.—LEVANDER, Acta Soc. Fauna et Flora Fennica, vol. 12, No. 3, 1894, p. 54, pl. 3, fig. 38.—SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 325.—STENROOS, Acta Soc. Fauna et Flora Fennica, vol. 17, No. 1, 1898, p. 167, pl. 3, fig. 3.—VORONKOV, Trudy Hidrobiol. Stantsii Glubokom Oz., vol. 2, 1907, p. 289.—V. HOFSTEN, Ark. Zool., Stockholm, vol. 6, No. 1, 1909, p. 63, text figs., part.—DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 192, text fig., part; not *Metopidia lepadella* of Ehrenberg, 1832.

Metopidia bractea HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 109.—SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 329; not *Brachionus bractea* Müller, 1786.

Metopidia elliptica TURNER, Bull. Denison Univ., vol. 6, 1892, p. 62, pl. 1, fig. 8.

Metopidia dentata TURNER, Bull. Denison Univ., vol. 6, 1892, p. 63, pl. 1, fig. 9.

?*Monostyla tentaculata* COSMOVICI, Naturaliste (Paris), vol. 14, 1892, p. 70; Anal. Acad. Rom., ser. 2, vol. 28, 1906, p. 44, text fig.

Metopidia parvula BRYCE, Journ. Quekett Micr. Club, ser. 2, vol. 5, 1893, p. 284.

Metopidia lepadella collaris LEVANDER, Acta Soc. Fauna et Flora Fennica, vol. 12, No. 3, 1894, p. 54, pl. 3, fig. 39.

Metopidia ovalis SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 328, pl. 7, fig. 21.

Metopidia collaris STOKES, Ann. Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 19, pl. 7, figs. 3, 4.

Metopidia collaris similis STOKES, Ann. Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 20, pl. 7, fig. 5.—RUNNSTRÖM, Zool. Anz., vol. 34, 1909, p. 273, text fig.

- Metopidia quadricarinata* STENROOS, Acta Soc. Fauna et Flora Fennica, vol. 17, No. 1, 1898, p. 165, pl. 3, fig. 2.
- Metopidia oblonga* v. HOFSTEN, Ark. Zool., Stockholm, vol. 6, No. 1, 1909, p. 63, text figs.—LIE-PETTERSEN, Tromsø Mus. Aarsh., vol. 33 (for 1910), 1911, p. 67.—DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 191, text fig.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 119, text figs.; not *Squamella oblonga* Ehrenberg, 1834.
- ? *Metopidia similis* LUCKS, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 191, text fig.; Rotatorienfauna Westpreussens, 1912, p. 119, text fig.
- Lepadella parvula* HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 64.
- Lepadella quadricarinata* HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 64.
- Metopidia patella* IROSO, Atti R. Ist. Incorr. Napoli, vol. 64 (for 1912), 1913, p. 474.

The outline of the lorica varies from nearly circular to moderately elongate oval and ovate, the most common forms being those of figures 1, 8 and 9; the width varies from two-thirds to four-fifths of the length. The dorsal plate is strongly convex and its edges overhang the nearly flat ventral plate; over the foot groove it is occasionally marked with two or four indistinct longitudinal folds or ridges, seldom found in the narrower specimens, but apparently constant in the widest specimens. On this peculiarity Stenroos's *Metopidia quadricarinata* was founded; it appears to be an individual rather than a specific character. The dorso-ventral depth of the body is about one-third the length of the lorica and nearly constant for all varieties, whether narrow or wide.

The width of the anterior opening is about one-fourth the length of the lorica. The dorsal sinus is broadly U-shaped and its depth is about one-half the width. The ventral sinus is approximately V-shaped, its sides slightly outcurved and the posterior angle rounded; the depth is a little less than the distance between the anterior points. Both dorsal and ventral plates have a stippled collar, strongly marked on the median line and disappearing gradually toward the sides.

The foot groove is approximately one-third the length of the lorica; its outline varies from nearly parallel-sided to slightly ovate. The posterior emargination is usually very shallow, with rounded corners, but varies to the lunate forms of figures 2 and 12, plate 90, with obtuse-angled points. The edges of the foot groove project slightly below the surface of the ventral plate as low ridges.

The foot is fairly stout; the first and second joints are very short and of equal length; the third joint is somewhat longer and has a sensory pit on its dorsal side. The toes are about one-third the length of the lorica; they are slightly decurved, with a certain amount of individual variation, and taper to fine points, the anterior half a little more rapidly than the posterior portion.

Total length, 135–145 μ ; length of lorica, 100–108 μ , width, 65–90 μ ; anterior points, 25–27 μ ; depth of dorsal sinus, 12–14 μ , of ventral sinus, 18–20 μ ; length of foot groove, 30–34 μ , width, 18–20 μ ;

length of foot, 32–35 μ , of last joint, 11–12 μ , of toes, 25–30 μ ; depth of body in median plane, 30–35 μ ; from highest point of dorsal plate to edges of lorica, 40–45 μ .

Lepadella patella occurs everywhere in weedy pools and ponds, as well as in wet mosses, and is in such places probably the most abundant of all rotifers. On account of its variability it has during its history received a considerable number of names. What the value of these variations may be is difficult to say; in a circumscribed locality they are usually slight, and it is only when material from widely separated regions is brought together and compared that the different forms are seen to overlap. Only some of the principal varieties have been illustrated. Intermediate forms joining all of these are to be found; but, as stated above, not in the same locality.

The nearest relative of this species appears to be *Lepadella ovalis*; the relative thickness of the body is sufficient to differentiate the two species. In *L. patella* this is one-third the length of the lorica, while in *L. ovalis* it is only one-fifth. The anterior opening is also relatively larger in *L. patella*, and the form of the ventral sinus is quite different in the two species. In *L. patella* it is roughly V-shaped and widest in front, while in *L. ovalis* the sinus is rhomboid, with the widest point some distance from the front.

Metopidia collaris Stokes appears, judging from the figure, to be a synonym of *L. patella*. In any case the name is not available, as it was previously used by Levander for a variety that is undoubtedly synonymous. Under the name *M. collaris* Stokes, Murray lists¹ from Sydney, Australia, the animal figured on plate 91, figures 3–5. This is drawn from a single mounted specimen given to me by Mr. Murray. Only the lorica is preserved, the foot and toes having disappeared. It is very evidently different from any known Lepadellid, but on account of the defective specimen it seems undesirable to give it any name. It is figured here to complete Murray's record and also in the hope that better material may eventually be discovered somewhere. The anterior opening is very peculiar and so is the broken lateral edge. It is barely possible that this may be due to the preservative. No details of the foot opening are available. The figure represents only the condition of the specimen and evidently not the normal structure. On the ventral plate there are two short longitudinal ridges quite close together. The dorsal plate has a median ridge, beginning a short distance from the anterior margin and continuing to the posterior point of the lorica. Two subdorsal ridges originate on the anterior points and reach very nearly to the end of the lorica. Length of lorica, 72 μ , width, 45 μ ; width of anterior margin, 15 μ ; depth of dorsal sinus, 5 μ , of ventral sinus, 18 μ ; dorso-ventral depth of lorica, 30 μ .

¹ Journ. Royal Micr. Soc., 1913, p. 460.

Specimens identified for me by Mr. Bryce as *Metopidia parvula* represent a Sphagnum-form which falls within the variation limits of *L. patella*. This is probably not true of the form described by Montet¹ as *M. parvula* Bryce. The shallow ventral sinus, absence of any dorsal sinus and the very large foot groove all indicate a very distinct species.

4. LEPADELLA LATUSINUS (Hilgendorf).

Plate 91, figs. 7-12.

Metopidia solidus latusinus HILGENDORF, Trans. and Proc. New Zealand Inst., vol. 31, 1899, p. 131, pl. 11, fig. 15d.

Metopidia latusinus MURRAY, Journ. Roy. Micr. Soc., 1911, p. 581, pl. 17, fig. 11.

Lepadella latusinus HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 63.

The body of this species is broadly oval or subovate in outline. The dorsal plate of the lorica is strongly convex and evenly rounded, with its edges slightly overhanging the nearly flat ventral plate. The width of the lorica is about three-fourths of the length of the dorsal plate and is subject to only slight variations. The cross section of the body is nearly semicircular, as the dorso-ventral depth is but little less than half the width.

The distance apart of the lateral points of the head opening is about one-fourth the length of the lorica. The dorsal sinus is broadly U-shaped and quite shallow, its depth not exceeding one-third of the width. The ventral sinus is deeply lunate, its depth being nearly two-thirds of the width. There is a certain amount of variation in the form of both the dorsal and the ventral sinus, as shown in figures 8-11. A stippled collar is present both dorsally and ventrally.

The length of the foot groove is one-third to one-fourth the length of the lorica; its form varies greatly. Anteriorly it is always evenly rounded; the sides may be moderately divergent, as in figure 8, or widely flaring, with the extremities recurved, as in figures 9 and 11; the posterior width may be from one-third to two-thirds of the length of the lorica. The lateral points always project beyond the lorica; in the narrower forms they are nearly square, while in the extreme varieties they show a strong outward curvature; in rare cases they are even slightly recurved. The posterior margin has in the narrower forms a shallow median emargination; in the widest forms a very slightly convex median lobe is interposed between two lateral emarginations. In other words, from the lateral angles the posterior margin always curves forward, the curvature being nearly constant in all varieties, while the widest forms have a slightly convex median lobe, which gradually disappears as the total width decreases.

The foot is stout and projects but little beyond the lorica; no sensory pit has been observed on the terminal joint. The toes are

¹ Rev. Suisse Zool., vol. 23, 1915, p. 339, pl. 13, fig. 37.

long, slender, and slightly decurved; they are about one-third the length of the lorica. They are nearly parallel-sided for one-third of their length and end in very slender points.

Total length, 138–142 μ ; length of lorica 98–105 μ , width 70–75 μ ; anterior points, 28 μ ; depth of dorsal sinus, 8–10 μ , of ventral sinus, 20–22 μ ; length of foot groove, 26–33 μ , width 32–65 μ ; length of foot, 22 μ , of terminal joint, 12 μ ; length of toes, 32 μ ; depth of body in median plane, 30 μ ; from highest point of dorsal plate to edges of lorica, 36 μ .

This species has not been found outside of New Zealand; I am indebted to Mr. Rousselet for the material on which this description is based; it was collected by Mr. Murray on the return trip of the Shackleton Antarctic Expedition.

5. LEPADELLA AMPHITROPIS, new species.

Plate 93, figs. 9–12.

The outline of the lorica is ovate, bluntly pointed posteriorly; its width is more than two-thirds of the length. The right and left halves of the dorsal and ventral plates are nearly flat and meet in the median plane at obtuse angles, so that the cross section of the body is rhomboid. On the dorsal plate there is a ridge, beginning a short distance behind the stippled collar and gradually becoming more prominent toward the posterior end of the lorica, where it is raised above the surface as a distinct keel, extending about one-third the length of the lorica. The depth of the body is one-third the length of the dorsal plate.

The opening for the head is about half the width of the lorica. The dorsal sinus is shallow and semielliptic; its depth is two-thirds of the width. The ventral sinus is roughly V-shaped, rounded posteriorly, and with slightly concave sides; the depth is equal to the width. Both the dorsal and the ventral plate have a stippled collar.

The foot groove is less than one-third the length of the lorica; it is slightly truncate anteriorly and the sides diverge somewhat toward the posterior end of the lorica, where they curve rapidly inward. In some specimens the foot groove is nearly parallel-sided, but this is rather unusual. The foot is of moderate length and projects slightly beyond the lorica; the terminal joint is a little longer than the first and second joints, which are nearly equal. A sensory pit is present on the dorsal side of the posterior foot joint. The toes are one-third the length of the lorica, very slender, and slightly decurved in the posterior half of their length.

Total length, 104 μ ; length of lorica, 76 μ , width, 54 μ ; width of anterior points, 22 μ ; depth of dorsal sinus, 8 μ , of ventral sinus, 22 μ ; length of foot groove, 21 μ , anterior width, 15 μ , posterior

width, 18 μ ; length of foot, 20 μ , of terminal joint, 8 μ ; length of toes, 24 μ ; depth of body, 28 μ .

Type.—Cat. No. 16827, U.S.N.M., was collected in sphagnum growing in the old gravel pit at Hyattsville, Maryland. It has also been found in a collection from the United States Bureau of Fisheries station at San Marcos, Texas.

6. *LEPADELLA QUINQUECOSTATA* (Lucks).

Plate 95, figs. 5-8.

Metopidia quinquecostata LUCKS, Süswasserfauna Deutschlands, pt. 14, 1912, p. 189, text fig.; Rotatorienfauna Westpreussens, 1912, p. 126, text fig.—

MURRAY, Journ. Royal Micr. Soc., 1913, pp. 450, 460, pl. 19, fig. 9.

Lepadella quinquecostata HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 64.

The lorica is distinctly pyriform in outline, narrowing perceptibly toward the head. The dorsal plate is, disregarding for the moment the lateral ridges, composed of two flat plates, meeting at an obtuse angle in the median line. The ventral plate is slightly concave and the cross section of the body approximately triangular. The dorsal plate has a median ridge, beginning a short distance behind the stippled collar as two indistinct, convergent lines, uniting about halfway down the dorsal plate and continued as a single, inconspicuous ridge to the extreme end of the lorica. Two ridges begin near the anterior points of the lorica and, converging very slightly throughout their length, continue a short distance past the lateral antennae, where the points turn sharply in toward the median ridge and then disappear. A second pair of strongly curved ridges, starting back of the collar and outside those already described, follow a course roughly parallel to the edges of the lorica and terminate just in front of the lateral antennae. These lateral ridges are all most prominent at their middle and decrease toward the ends. Their form will be understood from figure 8. The width of the lorica is two-thirds and the depth of the body a little less than one-third the length of the lorica.

The distance apart of the prominent anterior points is one-fourth the length of the lorica; the anterior sinus is broadly U-shaped, and its depth equals one-half its width. The ventral sinus is approximately V-shaped, its posterior angle slightly blunted, and the sides decidedly concave; its depth is a little less than its anterior width. The stippled collar, which is present on both the dorsal and the ventral plate, is very narrow on the median line and increases gradually in width as it disappears toward the sides of the lorica.

The foot groove is one-third the length of the lorica; it is rounded anteriorly and very nearly parallel-sided; the sides are occasionally slightly pinched in at the base of the foot, as shown in the ventral view; but as a rule this narrowing does not exist and the sides curve

gradually and very gently throughout their length. The posterior end of the lorica is slightly emarginate.

The foot is very robust and about one-fourth the length of the lorica. No sensory pit has been observed on the third foot joint. The stout toes are as long as the foot; they are nearly parallel sided for half their length and from there taper gently toward the point. They are not, strictly speaking, decurved; the lower or ventral edge is almost straight, while the dorsal edge curves downward to the point.

Total length, 135 μ ; length of lorica 105 μ , width 66 μ ; anterior points, 28 μ ; depth of dorsal sinus, 12 μ , of ventral sinus, 24 μ ; length of foot groove, 33 μ , anterior width, 16 μ , posterior width, 18 μ ; length of foot, 24 μ , of terminal joint, 9 μ ; length of toes, 27 μ ; depth of body, 30 μ .

Lepadella quinquecostata was found by Lucks in various localities near Danzig, Germany; Murray collected it at Sydney, Australia, and Rio de Janeiro, Brazil; by the writer it has been found in the Panama collections, made by Dr. C. Dwight Marsh from Rio Grande Reservoir, as well as in local collections from Kenilworth, District of Columbia. It usually occurs in small numbers only.

7. LEPADELLA CRYPHAEA, new species.

Plate 92, figs. 9-12.

The lorica is distinctly pyriform in outline; it is prolonged posteriorly as a bluntly pointed or slightly angulate projection with distinct basal inangulations. The cross section of this projection is triangular, and there is a fairly well marked median ridge; from the lateral angles an inconspicuous line continues forward to a point even with, and a little inside of, the lateral antennae. The dorsal plate is evenly rounded, its edges slightly overhanging the nearly flat ventral plate. The cross section of the body is approximately semicircular. The width of the lorica is three-fifths and the depth of the body one-third of the length of the dorsal plate.

The anterior margin is very narrow, about one-fifth of the length of the lorica. The dorsal sinus is broadly U-shaped; its depth is about half the width of the anterior margin. The ventral sinus is slightly elliptic and bluntly pointed posteriorly; the depth is three-fourths of the width. There is a stippled collar on both the dorsal and the ventral plate.

The foot groove is a little more than one-third the length of the lorica; its sides converge somewhat toward the posterior projection. The foot is rather slender and projects very little beyond the lorica; its three joints are of nearly equal length. The toes are slender and taper gradually to fine points; their length, one-fourth that of the

lorica, is somewhat less than the average. No sensory pit has been found on the posterior foot joint.

Total length, 130 μ ; length of lorica 97 μ , width 58 μ ; width of anterior points, 21 μ ; depth of dorsal sinus, 10 μ , of ventral sinus, 15 μ ; length of foot groove, 28–30 μ , anterior width, 19 μ , posterior width, 15 μ ; length of foot, 26 μ , of terminal joint, 9 μ ; length of toes, 24 μ ; depth of body, 34 μ .

Type.—Cat. No. 16828, U.S.N.M., was collected from a species of moss, *Amblystegium irriguum*, growing submerged on the rocks in a small stream near the United States Bureau of Standards, District of Columbia.

Lepadella cryphaea is undoubtedly closely related to *L. acuminata*, but differs consistently in the following characters: The lorica is always distinctly pyriform and the anterior margin very narrow, one-fifth the length of the lorica; the foot projects slightly beyond the lorica and the toes are only one-fourth the length of the lorica. In *L. acuminata* the lorica is nearly always oval and may be ovate, but is never pyriform; the width of the anterior margin is one-fourth the length of the lorica. The posterior point of the lorica projects beyond the foot and the toes are fully one-third the length of the lorica, and much more slender than in *L. cryphaea*. These characters selected for comparison are among the most constant in the genus, and the two forms may therefore with reasonable certainty be considered distinct species.

8. LEPADELLA ACUMINATA (Ehrenberg).

Plate 92, figs. 4–8.

Metopidia acuminata EHRENBURG, Abh. Akad. Wiss., Berlin (for 1833), 1834, p. 210; Infusionsth., 1838, p. 477, pl. 59, fig. 10.—ECKSTEIN, Zeitschr. wiss. Zool., vol. 39, 1883, p. 387, pl. 27, fig. 52.—HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 107, pl. 25, fig. 9.—LEVANDER, Acta Soc. Fauna et Flora Fennica, vol. 12, No. 3, 1894, p. 55.—WEBER, Rev. Suisse Zool., vol. 5, 1898, p. 635, pl. 22, figs. 28–30.—DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 188, text fig.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 118.—MONTET, Rev. Suisse Zool., vol. 23, 1915, p. 338.

Lepadella acuminata DUJARDIN, Hist. Nat. Zooph., 1841, p. 633.

The body is usually oval in outline, in rare instances somewhat ovate, as shown in figure 8; the width is about three-fourths of the length. Posteriorly the lorica is prolonged into a pointed projection, usually merging gradually with the edges of the lorica, but occasionally with a slight constriction at the base. (See fig. 8.) The dorsal plate is strongly convex and evenly rounded; it is usually marked with faint ridges, some or all of which may be absent. A median ridge on the posterior third of the dorsal plate and continuing to the terminal point of the lorica is nearly always present; it may be approximately paralleled at its base by two short, slightly con-

vergent ridges, which do not reach the end of the lorica. Two curved ridges, nearly parallel to the edges of the dorsal plate, begin at about mid-length and terminate just above the lateral antennae. This pair of ridges is frequently absent. The ventral plate is nearly flat. The cross section of the body is approximately semicircular; the dorso-ventral depth is a little more than one-third the length of the lorica.

The width of the anterior margin is one-fourth the length of the lorica. The dorsal sinus is broadly U-shaped; its depth is a little more than half the anterior width. The ventral sinus is semi-elliptic, slightly pointed posteriorly; its depth is two-thirds of the width. A stippled collar is present on the dorsal plate; the ventral plate may have a very faint collar, but is usually without any.

The foot groove is one-third the length of the lorica and of elongate ovate form; its width is a little less than one-half the length. The foot is moderately stout and about one-fourth the length of the body. No sensory pit has been found on the terminal joint. The toes are one-third the length of the lorica, very slender, and nearly straight.

Total length, 144 μ ; length of lorica 109 μ , width 72 μ ; width of anterior margin, 27 μ ; depth of dorsal sinus, 15 μ , of ventral sinus, 18 μ ; length of foot groove, 38 μ , width, 16 μ ; length of foot, 26 μ ; length of toes, 35 μ ; depth of body, 42 μ .

Lepadella acuminata is of world-wide distribution and usually fairly common.

9. LEPADELLA DACTYLISETA (Stenroos).

Plate 92, figs. 1-3.

Metopidia dactyliseta STENROOS, Acta Soc. Fauna et Flora Fennica, vol. 17, 1898, p. 165, pl. 3, fig. 1.

Metopidia rottenburgi LUCKS, Rotatorienfauna Westpreussens, 1912, p. 127, text fig.

Lepadella rottenburgi HARRING, Bull. SI U. S. Nat. Mus., 1913, p. 65.

The body is subrhomboid in outline and unusually narrow posteriorly; its width is two-thirds of the length of the dorsal plate. The dorsal plate is strongly convex and the ventral plate slightly concave; the cross section of the body is nearly semicircular.

The anterior margin of the dorsal plate is without any sinus and usually slightly convex; the ventral sinus is V-shaped, with slightly convex sides, which meet posteriorly in a fairly sharp point. The width of the anterior margin is one-third the length of the lorica; the depth of the ventral sinus is a little more than half the width of the anterior margin. There is no stippled collar, but an inconspicuous line parallels the sides of the ventral sinus.

The foot groove is rather short, about one-fourth the length of the lorica, and unusually narrow, its width being little more than half the length. The sides of the foot groove converge slightly toward

the posterior end of the lorica, which is squarely truncate or very slightly emarginate.

The foot is one-fourth the length of the lorica and quite stout; its three joints are of approximately equal length. The toes are one-third the length of the lorica and taper rather rapidly for one-half their length, ending in long, slender points.

Total length, 127 μ ; length of lorica, 90 μ , width, 60 μ ; width of head opening, 30 μ ; depth of ventral sinus, 17 μ ; length of foot groove, 24 μ , anterior width, 15 μ , posterior width, 12 μ ; length of toes, 32 μ ; depth of body, 38 μ .

A few specimens of this species have been found by the writer in Lake Smith, the source of the water supply of the city of Norfolk, Virginia. It does not appear to have been recorded by anybody but Stenroos and Lucks, so that it is probably rare; while without any striking peculiarities, it is yet a fairly well marked species and it is not likely to have been overlooked.

10. LEPADELLA BENJAMINI, new species.

Plate 93, figs. 1-8.

The form of the lorica varies from subcircular to broadly ovate; the extremes are shown in figures 1 and 2. The dorsal plate is evenly and very strongly arched; its edges project considerably below the general level of the nearly flat ventral plate; posteriorly it is slightly emarginate over the foot groove. The width of the body varies from three-fourths to seven-eighths of the length of the lorica. The cross section of the body is approximately semicircular; its dorso-ventral depth is more than half the width of the lorica.

The width of the anterior margin is a little less than one-third the length of the body. There is no dorsal sinus; the frontal edge of the dorsal plate is almost straight or very slightly concave. The ventral sinus is U-shaped and somewhat angulate; its depth is two-thirds the width of the anterior margin. The stippled collar present on both the dorsal and the ventral plate is unusually narrow. The lateral edges of the lorica are slightly constricted immediately behind the anterior margin, giving this a necklike appearance.

The foot groove is shorter than in any other species of the genus, its length being only one-fifth of the length of the lorica; the outline is roughly trapezoid, truncate anteriorly, and with diverging sides. The posterior width is nearly one-fourth the length of the lorica.

The foot is approximately one-fourth the length of the body; it is fairly stout and its three joints are of nearly equal length. A sensory pit on the terminal foot joint has not been observed. The toes are extremely long, two-fifths the length of the lorica, and slightly decurved; they taper rather rapidly to the nearly cylindrical or very slightly conical posterior portion.

Total length, 180 μ ; length of lorica, 114 μ , width, 85–100 μ ; width of anterior margin, 35 μ ; depth of ventral sinus, 24 μ ; length of foot groove, 24 μ , posterior width, 30 μ ; length of foot, 30 μ , of last joint, 12 μ ; length of toes, 45 μ ; depth of body in median plane, 43 μ ; from highest point of dorsal plate to edges of lorica, 52 μ .

Type.—Cat. No. 16829, U.S.N.M., was collected in weedy ponds at Kenilworth, District of Columbia. It is fairly common. Mr. Murray brought me a specimen which he collected at Sydney, Australia.

The corona, figures 5 and 6, and the trophi, figures 7 and 8, have been described in the introduction, so that a repetition is unnecessary.

Lepadella benjamini is easily recognized by the great dorso-ventral depth of the body and the overhanging edges of the lorica, recalling *Euchlanis pyriformis*, as well as by the very short foot groove and the unusually long toes. It is surpassed in size only by *L. ovalis* (Müller), while the actual bulk is probably greater.

This species has been named for Dr. Marcus Benjamin, editor of the publications of the United States National Museum.

11. LEPADELLA CYRTOPIUS Harring.

Plate 93, figs. 13–16.

Lepadella cyrtopus HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 550, pl. 16, figs. 6–8.

The body is broadly oval and usually somewhat truncate posteriorly. The dorsal plate is evenly rounded, and its edges do not project below the level of the ventral plate. The latter is nearly flat, with a very shallow longitudinal depression near each lateral edge. The width of the body is equal to four-fifths of the length of the lorica; its cross-section is semicircular.

There is no distinct dorsal sinus, but the anterior margin of the dorsal plate is slightly concave. Its width is one-third the length of the lorica. The ventral sinus is very deep, about four-fifths of its anterior width, and subcircular in outline. A bead-like thickening of the dorsal and ventral edges of the opening for the head is present, but no stippled collar.

The foot groove is short, broadly U-shaped, and its sides slightly divergent posteriorly. Its length is one-fourth the length of the lorica, and the width is very nearly the same. The posterior margin of the lorica varies from the broadly truncate form of figure 13 to that of figure 14, where the truncation is very slight.

The length of the foot is two-fifths the length of the body, the second joint being nearly half the entire length. The toes are short, less than one-fourth the length of the lorica, and strongly

asymmetric. The right toe tapers rapidly for half its length and ends in a slender, nearly cylindrical point. The left toe tapers gradually to the point and is strongly decurved. The last joint of the foot is twisted, so that the curved left toe is almost directly under the right toe.

Total length, 98 μ ; length of lorica, 70 μ , width, 56 μ ; width of anterior margin, 24 μ ; depth of ventral sinus, 19 μ ; length of foot groove, 17 μ , posterior width, 15 μ ; length of foot, 26 μ , of second foot joint, 11 μ ; length of right toe, 16 μ ; depth of body, 29 μ .

Type.—Cat. No. 16585, U.S.N.M., was collected in Camacho Reservoir, on the Isthmus of Panama. This species occurs rather widely distributed on the Isthmus, but usually in small numbers. It has been found by the writer in Lake Smith, near Norfolk, Virginia, and in collections made by Dr. E. A. Birge, of the University of Wisconsin, in Rondeau Harbor, Ontario, on the Canadian shore of Lake Erie, and in ponds in Audubon Park, New Orleans, Louisiana.

12. *LEPADELLA BIDENTATA* Voronkov.

Plate 91, fig. 6.

Lepadella dactyliseta bidentata VORONKOV, Trudy Hidrobiol. Stants. Glubokom Oz., vol. 5, pt. 1, 1913, pp. 99, 107, text fig.

Metopidia dactyliseta bidentata VORONKOV, Trudy Dnieprovsk. Biol. Stants., pt. 2, No. 5, 1915, p. 71, text fig.

This species has not been studied by the writer. The figure is redrawn from the original by Voronkov, which shows an animal with marked differences from *Lepadella dactyliseta* (Stenroos) and evidently entitled to specific rank.

The original description is not very detailed, but the figure shows the lorica to be broadly oval and without any dorsal sinus. The ventral sinus is very deep, rounded posteriorly, and fairly wide anteriorly. The posterior end of the lorica has a small, rounded median lobe and, separated from this by shallow emarginations, two small spines. The toes are straight and parallel-sided for one-half their length and taper somewhat abruptly to slender points. No measurements are given in the text.

Voronkov found three specimens in the Desenka, a tributary to the Dniepr, near Kiev, Russia.

13. *LEPADELLA BOREALIS*, new species.

Plate 92, figs. 13-16.

The lorica is usually pyriform in outline and obtusely pointed posteriorly, but may be slightly constricted in the region of the lateral antennae, as shown in figure 14. The dorsal plate is evenly rounded and moderately convex; the ventral plate is slightly con-

cave. The width of the body is four-fifths the length of the dorsal plate. The cross-section of the body is a shallow segment of a circle. Its depth is one-third the length of the lorica.

The anterior margin is very wide, more than one-third the length of the dorsal plate. The dorsal sinus is very shallow and broadly U-shaped. Its depth is one-fourth of the width. The ventral sinus is V-shaped, with nearly straight sides diverging approximately at a right angle, and slightly rounded posteriorly. Its depth is a little more than half the width. Both the dorsal and the ventral plate have a stippled collar.

The foot groove is short, measuring but one-fourth the length of the lorica from the base to the points where the sides of the groove meet the posterior edge of the lorica. Its outline is trapezoid, truncate anteriorly, and with widely divergent sides. Posteriorly its width is one-third the length of the body.

The foot is one-third the length of the body. Its three joints are of nearly equal length. The toes are one-third the length of the lorica, parallel-sided for about one-third of their length and then taper abruptly to slender, nearly cylindrical points about half the entire length of the toe. At the base the toes are coalescent for about one-fourth of their length, and consequently inseparable, so that their movements are those of a single toe, as in the genus *Monostyla*.

Total length, 145 μ ; length of lorica, 102 μ ; width, 80 μ , width of anterior margin, 36 μ ; depth of dorsal sinus, 9 μ , of ventral sinus, 20 μ ; length of foot groove to junction of sides and edges of ventral plate, 24 μ , to posterior angle of lorica, 30 μ , posterior width, 30–33 μ ; length of foot, 30 μ , of last foot joint, 12 μ ; length of toes, 35 μ , of basal ankylosis, 8 μ ; depth of body, 32 μ .

Type.—Cat. No. 16830, U.S.N.M., from Ice House Pond, St. Paul Island, Alaska. This collection was made by Dr. G. H. Parker, of Harvard University, while acting as a member of the commission for the investigation of the Alaskan fur seals, appointed by the Secretary of Commerce in 1914. St. Paul Island is the largest and northernmost island of the Pribilof group in Bering Sea; the distance from the mainland of Alaska is about 300 miles, from the Aleutian chain of islands about 200 miles.

This species is interesting on account of the sidelight it affords on the generic significance of the single toe in *Monostyla*, as opposed to the two toes of *Lecane* (= *Cathypna*). We have here what is in every other respect a typical *Lepadella*, possessing all the structural peculiarities of its congeners, and yet having developed what is to all intents and purposes a single toe, as in *Monostyla*. It is a fair inference that the generic value of the single toe of *Monostyla* is but slight; this is also corroborated by the otherwise identical, or rather parallel, structure of *Lecane* and *Monostyla*, even in minute details.

14. LEPADELLA HETEROSTYLA (Murray).

Plate 94, figs. 9-13.

?*Metopidia rhomboides* v. HOFSTEN, Ark. Zool., Stockholm, vol. 6, No. 1, 1909, p. 70, text fig.—DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 190, text fig., not *Metopidia rhomboides* Gosse, 1886.

Metopidia heterostyla MURRAY, Journ. Royal Micr. Soc., 1913, p. 459, pl. 19, fig. 6.

The lorica is broadly rhomboid and has a well-marked posterior emargination. The edge of the lorica curves upwards from the blunt lateral angles toward the anterior margin, the curvature increasing from the angles toward the opening for the head, where it is rolled back upon the dorsal plate, so that the actual outer edge does not represent the morphological outer edge. The nature of this peculiar structural modification is illustrated in figures 12 and 13, figure 12 being a cross section through the angles of the lorica, and figure 13 at the point of greatest curvature, about halfway between the lateral angles and the anterior margin. The width of the lorica is equal to the length. The dorsal plate is strongly convex in its median section and becomes gradually recurved toward the lateral angles; posteriorly it curves slightly upwards in the region of the lateral antennae and again over the foot groove, where the upward curvature is greater. The ventral plate is moderately convex and follows in general the sinuations of the dorsal plate. The cross section of the body consists of a roughly cylindrical median portion, produced laterally as two thin wings, merging gradually with the cylindrical median section; the general proportions of figure 12 are maintained, with reduced dimensions, from the lateral angles to the posterior end of the lorica.

The width of the anterior margin is one-third the length of the lorica. The dorsal sinus is broadly U-shaped and very shallow, its depth being only one-third of the width; the ventral sinus is semi-elliptic in outline and its depth equal to half the width. A stippled collar is present on both the dorsal and the ventral plate.

The foot groove is U-shaped and one-third the length of the lorica; its sides gradually merge into the curved ventral plate and disappear entirely at the posterior end of the body; its width is two-thirds of the length. There is a semicircular emargination between two rounded lobes at the posterior angle of the lorica.

The foot is long and slender, about one-third the length of the body; the terminal joint is a little more than half the length of the entire foot and has posteriorly a sensory pit. The toes are as long as the foot and are somewhat asymmetric; they both taper gradually toward the point, but the right toe is nearly straight, while the left toe curves away from it, increasing in curvature toward the point. The last foot joint is twisted, so that, instead of both toes being in

the same transverse plane, the left toe is almost directly under the right toe.

Total length, 134 μ ; length of lorica, 88 μ , width at lateral angles, 90 μ ; width of anterior margin, 27 μ ; depth of dorsal sinus, 10 μ , of ventral sinus, 14 μ ; length of foot groove, 28 μ , width, 18 μ ; length of foot, 32 μ , of posterior joint, 18 μ ; length of right toe, 32 μ , of left toe, 26 μ ; depth of body, 36 μ .

The material upon which this description is based was given to the writer by Mr. Murray; it was collected in a pond at Sydney, Australia. As stated by Murray, the animal figured by v. Hofsten and copied by Dieffenbach under the name of *Metopidia rhomboides* appears to be the same species; v. Hofsten found a single specimen in the "Mästermyr," a swampy area on the island of Gotland.

15. LEPADELLA EHRENBERGII (Perty).

Plate 94, figs. 1-4.

Notogonia ehrenbergii PERTY, Mitth. Nat. Ges. Bern., 1850, p. 20; Zur Kenntn. kleinst. Lebensf., 1852, p. 42, pl. 1, fig. 5.—HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 60, pl. 33, fig. 38.

Metopidia angulata ANDERSON, Journ. Asiatic Soc. Bengal, vol. 58, 1889, pt. 2, p. 356, pl. 21, fig. 10.

Metopidia notogonia TERNETZ, Rot. Umg. Basels, 1892, pp. 19, 34.

Metopidia ehrenbergii JENNINGS, Bull. Michigan Fish Comm., No. 3, 1894, p. 26.—WEBER, Zool. Jahrb., Syst., vol. 24, 1906, p. 216.—v. HOFSTEN, Ark. Zool., Stockholm, vol. 6, No. 1, 1909, p. 72, text fig.—LIE-PETTERSEN, Bergens Mus. Aarb. (for 1909), 1910, No. 15, p. 70, pl. 2, fig. 15.—DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 186, text fig.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 459, pl. 19, fig. 8.—PENARD, Rev. Suisse Zool., vol. 22, 1914, p. 8.

Lepadella ehrenbergii HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 63.

The normal form of this species, to which the following description refers unless specially noted, is shown in the dorsal view, figure 2: Figure 1 represents a local, slightly aberrant race. The lorica is broadly ovate in outline and produced postero-laterally into two broad triangular spurs, curving upward and forward; at the sides of the foot groove there are two similar but smaller and less curved spurs. The lateral spurs have on the dorsal side a central ridge and are triangular in cross section. The width of the body over the lateral spurs equals the length of the lorica; immediately in front of the spurs the width is approximately two-thirds of the length. The depth of the body, which is greatest near mid-length, is more than one-third of the length. The dorsal plate is strongly convex and evenly rounded; the ventral plate is nearly flat. The cross section of the body in front of the spurs is nearly semicircular; figure 4 represents a section through the spurs, where the dorso-ventral depth is much smaller.

The anterior margin is very wide, nearly one-third the length of the lorica. The dorsal sinus is very shallow and evenly rounded; its depth is about one-fourth of its width. The ventral sinus is

semielliptic in outline and its depth two-thirds of the width of the anterior margin. There is a broad stippled collar on both the dorsal and the ventral plate.

The foot groove is rounded anteriorly, its sides slightly divergent and somewhat curved, the curvature increasing toward the posterior end of the lorica. The length and width of the foot groove are nearly equal and a little more than one-fourth the length of the body. The posterior emargination may be evenly rounded, as in figure 1, or V-shaped and slightly truncate anteriorly, as in figure 2; its depth varies from two-fifths to one-half of its width.

The foot is moderately stout and about one-third the length of the lorica; the third joint is one-half the entire length; it has posteriorly a sensory pit. The toes are very long, about one-third the length of the body, and strongly asymmetric; both are slender and taper gradually to very fine points. The right toe is straight and the left toe slightly curved and bent downwards, away from the right toe. The last foot joint is twisted, so that the left toe is directly under the right.

Figure 1 represents a variety from Lake Smith, near Norfolk, Virginia. It differs in several respects from the normal form; the anterior margin is considerably narrower and the lorica much wider. The lateral spurs are broader at the base and less curved; the posterior spurs are more slender and somewhat longer than in the common form.

Total length, 132 μ ; length of lorica 94 μ , width over lateral spurs 75–90 μ ; width of anterior margin, 24–30 μ ; depth of dorsal sinus, 8 μ , of ventral sinus, 16 μ ; length of foot groove, 27 μ ; width of posterior spurs, 26–30 μ ; depth of posterior emargination, 10–12 μ ; length of foot, 28 μ , of last joint, 15 μ ; length of right, straight toe, 32 μ , of left, curved toe, 27 μ ; depth of body, 35 μ .

The distribution of this species appears to be somewhat erratic; it has been recorded from Switzerland, Germany, Sweden, Norway, India, Australia, and a few localities in the United States, but as a rule only from restricted areas. It is of interest to note its occurrence in a collection made by Mr. J. M. Jessup from lakes on Old Crow River flats, on the boundary line between Alaska and Canada, 40 miles north of the Porcupine River, lat. 68° N., long. 141° W., or well within the Arctic Circle. Where it does occur, it is, according to the experience of the writer, fairly common.

16. LEPADELLA PTERYGOIDA (Dunlop).

Plate 94, figs. 5–8.

Metopidia pterygoidea DUNLOP, Journ. Quekett Micr. Club, ser. 2, vol. 6, 1897, p. 325, pl. 17, figs. 1–3.

Lepadella pterygoidea HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 64.

The outline of the lorica is broadly oval and produced postero-laterally into two roughly triangular spurs, which give the entire

body a trianguloid appearance; posteriorly the lorica is constricted in the region of the foot groove and the extreme end is quite narrow. The width of the body over the spurs is equal to the length of the lorica. The spurs are slightly outcurved and very slightly decurved; the principal part of the spur is rather narrow, while the base is somewhat abruptly widened and merges gradually with the lorica. The dorsal plate is tectiform and has three pairs of longitudinal ribs or ridges. The medial or innermost pair of ridges are inconspicuous and quite close together, separated by a shallow groove; no definite length can be assigned to these ridges, as they gradually disappear, but they are approximately one-third the length of the lorica. The intermediate pair of ridges are lamellar and project from the dorsal plate as distinct keels, highest in the middle; anteriorly they are nearly parallel and do not quite reach to the collar, while posteriorly they gradually converge and disappear without attaining the posterior end of the lorica. The external pair of ridges are not very prominent; they are somewhat wavy and nearly parallel; anteriorly they seem to reach the edge of the lorica, some distance behind the collar, but posteriorly they terminate in front of the spurs. The ventral plate is very nearly flat. The cross section of the body is roughly a low, obtuse-angled triangle; the relative prominence of the longitudinal ridges is shown in figure 8. The dorso-ventral depth of the body is less than one-third the length of the lorica.

The anterior margin is extremely broad, nearly one-half the length of the lorica; there is really no dorsal sinus present, as the anterior points are wholly on the ventral plate, but the frontal margin of the dorsal plate is slightly concave. The ventral sinus is broadly V-shaped and slightly rounded posteriorly; its depth is less than half the width of the anterior margin. There is a very narrow stippled collar, of nearly the same width everywhere; it is continuous around the anterior opening and does not disappear at the edges of the lorica, as usual.

The foot groove is ovate, widest anteriorly, its edges slightly convergent and gradually disappearing before reaching the posterior end of the lorica. The length of the foot groove is somewhat less than one-third the length of the lorica, its width about one-half the length. The posterior end of the lorica is distinctly tectiform and has a shallow, V-shaped emargination, slightly rounded anteriorly.

The foot is moderately stout and a little less than one-third the length of the body; the first and second joint are of nearly the same length, while the third is somewhat longer. There is a sensory pit on the last foot joint. The toes are as long as the foot, straight and slender, and taper gradually to acute points.

Total length, 95 μ ; length of lorica, 70 μ , width over spurs, 74 μ ; width of anterior margin, 30 μ ; depth of dorsal emargination, measured from anterior points, 9 μ ; depth of ventral sinus, 12 μ ; length of

foot groove, 22 μ , width, 12 μ ; width of posterior margin of lorica, 12 μ ; length of foot, 21 μ , of last joint, 9 μ ; length of toes, 20 μ ; depth of body, 23 μ .

This description is from a single specimen, found in moss from the gravel pit at Hyattsville, Maryland. It differs in a number of points from Dunlop's original description and Dixon-Nuttall's figure; Dunlop's animal is considerably narrower anteriorly, but this may possibly be due to his having studied an extended specimen; the figure shows a median ridge on the dorsal plate, which is certainly not present in the Hyattsville specimen; the intermediate pair of ridges are shown as similar in form to the other two pairs, while in my specimen there are two distinct keels projecting above the general level of the dorsal plate. However, the similarity is so great that the existence of two species seems improbable, and we may perhaps ascribe some of the differences to difficulties of observation, others to the known variability of the members of this genus.

Lepadella pterygoida is evidently extremely rare; Dunlop found only two specimens. With the single specimen here described the records of its appearances seem to be exhausted.

17. LEPADELLA IMBRICATA Harring.

Plate 95, figs. 9-11.

Lepadella imbricata HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 549, pl. 16, figs. 3-5.

The lorica is ovate in outline and very slightly constricted at the anterior margin. The dorsal plate is tectiform with a shallow groove on each side, equidistant from the edge of the lorica and an inconspicuous median ridge; its edges project very slightly below the nearly flat ventral plate. The cross section of the body is obscurely tri-radiate; in this respect *L. imbricata* is the least specialized member of the *Metopidia* group. The dorso-ventral depth of the body is nearly one-half the length of the lorica.

The width of the anterior margin is a little less than one-third the length of the lorica. No dorsal sinus is present, the frontal edge of the dorsal plate being nearly straight. The ventral sinus is broadly V-shaped and pointed posteriorly; its depth is two-thirds of the width of the anterior margin. Neither a stippled collar nor the bead-like thickening of the anterior margin occasionally taking its place is present in this species.

The foot groove is U-shaped and very narrow, rounded anteriorly and with parallel sides; its length is a little less than one-third the length of the lorica and the width somewhat more than half the length. The lorica is rounded posteriorly, without any emargination.

The foot is nearly two-fifths of the length of the body and quite slender; the terminal joint is more than half the entire length. No

sensory pit on the foot has been observed. The toes are nearly one-third the length of the lorica, slender, and almost straight; they taper gradually to very fine points.

Total length, 128 μ ; length of lorica, 86 μ , width, 54 μ ; width of anterior margin, 29 μ ; depth of ventral sinus, 18 μ ; length of foot groove, 25 μ , width, 15 μ ; length of foot, 32 μ , of last joint, 18 μ ; length of toes, 27 μ ; depth of body, 39 μ .

Type.—Cat. No. 16586, U.S.N.M., was collected at Kenilworth, District of Columbia; on the Isthmus of Panama it was collected by Dr. C. Dwight Marsh at Empire and in Rio Trinidad, at Escoval. Dr. Chancey Juday, of the University of Wisconsin, collected this species at Puerto Barrios, Guatemala. It appears to be a rare animal, only a few specimens occurring in each of the collections mentioned.

18. LEPADELLA RHOMBOIDES (Gosse).

Plate 95, figs. 12–15.

Metopidia rhomboides Gosse, Hudson and Gosse, Rotifera, 1886, vol. 2, p. 108, pl. 25, fig. 10.—WIERZEJSKI, Rozpr. Akad. Umiejjetn., Wydz. Mat.-Przyr., ser. 2, vol. 4, 1893, p. 246, pl. 6, fig. 46.—? SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 328.—LIE-PETERSEN, Bergens Mus. Aarb. (for 1909), 1910, No. 15, p. 70.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 123, text fig.—MURRAY, Journ. Roy. Micr. Soc., 1913, p. 459.

Lepadella rhomboides HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 65.

The lorica is rhomboid-ovate in outline; its width is about two-thirds of the length. The dorsal plate is moderately convex, with a very wide and moderately high keel, beginning at the anterior margin and continuing to the end of the lorica. The sides of the keel are strongly convex and meet at an obtuse angle, thus forming a faint median ridge. The ventral plate is slightly concave. The entire surface of the lorica is covered with a "moiré" pattern of short, nearly straight and parallel lines or minute wrinkles. The cross section of the body is moderately triradiate, as shown in figure 15; the width of the keel is a little less than one-third the width of the dorsal plate; the dorso-ventral depth of the body is nearly one-third the length of the lorica.

The anterior margin is rather narrow, its width being only one-fourth the length of the lorica. The dorsal sinus is broadly U-shaped with a small median notch; its depth is one-third of the width. The ventral sinus is V-shaped and pointed posteriorly; the depth is two-thirds of the width of the anterior margin. No collar is present on either the dorsal or the ventral plate.

The foot groove is U-shaped and quite narrow, rounded anteriorly and with parallel sides; its length is a little less than one-third the length of the body, and the width is equal to one-half its length. The lorica is rounded posteriorly, without any emargination.

The foot is approximately one-third the length of the lorica and fairly stout; the third joint is a little longer than both anterior joints and has a dorsal sensory pit. The toes are short, less than one-fourth the length of the body; they are slightly decurved and taper rather rapidly to slender points.

Total length, 156 μ ; length of lorica, 120 μ , width, 80 μ ; width of anterior margin, 29 μ ; depth of dorsal sinus, 11 μ , of ventral sinus, 20 μ ; length of foot groove, 37 μ , width, 19 μ ; length of foot, 35 μ , of last joint, 19 μ ; length of toes, 26 μ ; depth of body in median plane, 36 μ , to edges of lorica, 44 μ .

This species is widely, but apparently rather irregularly distributed; it usually occurs in small numbers.

19. LEPADELLA CRISTATA (Rousselet).

Plate 96, figs. 5-12.

Colurus cristatus ROUSSELET, Journ. Royal Micr. Soc., 1893, p. 446, pl. 7, fig. 2.

Metopidia cristata VORONKOV, Trudy Hidrobiol. Stants. Glubokom Oz., vol. 2, 1907, p. 112, pl. 7, figs. 39-42.

Metopidia mucronata DADAY, Math. Term. Ért., vol. 26, 1908, p. 30; not *Lepadella mucronata* Schmarda, 1859.

Metopidia semicarinata LUCKS, Ber. Westpreuss. Bot.-Zool. Ver., vol. 31, 1909, p. 141.—DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 189, text fig.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 124, text fig.

Metopidia semicarinata tripteris LUCKS, Ber. Westpreuss. Bot.-Zool. Ver., vol. 31, 1909, p. 141.—DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 189.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 125; not *Lepadella triptera* Ehrenberg, 1832.

Lepadella cristata, HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 63.

The lorica is broadly oval in outline, slightly constricted near the anterior margin, and truncate posteriorly; its width is three-fourths of the length. The dorsal plate is convex and has a high median keel, prominent at the anterior margin and increasing in height until reaching the middle of the dorsal plate; from this point the height decreases gradually toward the posterior end of the lorica. A large spine is nearly always present on the anterior half of the keel; it is extremely variable in size and form, as shown by figures 8 to 11, and may be completely absent, as in figure 7; perhaps the commonest form is that represented by figure 10. The spine is strongly compressed laterally; the base is quite narrow and the dorsal edge linear. Longitudinally the base of the spine usually extends about half the length of the lorica; its length, measured from the anterior margin to the tip, may in extreme individuals be almost equal to the length of the lorica, but is more commonly about half the length. The ventral plate is nearly flat, slightly decurved at the edges. The cross section of the body is triradiate; at its highest point the keel is comparatively thin with moderately concave sides. The dorso-ventral depth of the body is one-half the length.

The width of the anterior margin is a little more than one-third the length of the lorica. No dorsal sinus is present; the frontal edge of the dorsal plate has a shallow median emargination between two slightly convex lobes. The ventral sinus is V-shaped and pointed posteriorly; its depth is one-fourth the length of the lorica. The dorsal plate has a narrow stippled collar, interrupted by a small median triangular space; the ventral sinus has a comparatively wide, thickened border of semielliptic outline and with two rounded lateral lobes. (See fig. 5.)

The foot groove is rather short and wide, semielliptic in outline; its length is but little more than one-fourth the length of the lorica and its width four-fifths of the length. The posterior end of the lorica is very slightly emarginate over the foot groove.

The foot is fairly stout and somewhat more than one-third the length of the body; the posterior joint is half the length of the entire foot. The toes are one-fourth the length of the lorica and rather slender, with slightly recurved points. There is a sensory pit on the dorsal side of the last foot joint.

Total length, 180 μ ; length of lorica 118 μ , width 90 μ ; width of anterior margin, 34 μ ; depth of ventral sinus, 30 μ ; length of foot groove, 34 μ , width, 27 μ ; length of foot, 45 μ , of last joint, 22 μ ; length of toes, 32 μ ; depth of body, 60 μ .

This species was originally described by Rousselet from notes and sketches by Mrs. Pell, of Highland Falls, New York. It seems to be widely distributed in the eastern half of the United States, and is occasionally found in considerable numbers. Daday figures it from African collections under the name *Metopidia mucronata* (Schmarda), giving *Lepadella mucronata* Schmarda as synonym. As far as may be judged from Schmarda's minute figure, his was an entirely different form, with a high keel extending the entire length of the lorica and continued beyond the posterior end of the body as a long spine. If Schmarda's figure correctly represents the animal he found, it is obviously very different from *L. cristata*.

20. LEPADELLA RHOMBOIDULA (Bryce).

Plate 96, figs. 1-4.

Metopidia rhomboidula BRYCE, Science Gossip, vol. 26, 1890, p. 76, text figs.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 459, pl. 19, fig. 7.—MONTET, Rev. Suisse Zool., vol. 23, 1915, p. 339.

Lepadella rhomboidula HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 65.

The body is very broadly rhomboid in outline; its width is equal to the length. The dorsal plate is slightly convex and has a high median keel, extending the entire length of the lorica. The sides

of the keel are somewhat concave and meet in the median plane at a rather acute angle, thus forming a pronounced dorsal ridge; there is no distinct lateral groove, as the sides of the keel merge very gradually with the dorsal plate. The cross section of the body is triradiate; the lateral, wing-like portion of the body is very thin. The dorso-ventral depth of the lorica is somewhat less than half the length of the body.

The width of the anterior margin is a little less than one-third the length of the lorica. No dorsal sinus is present, but the frontal edge of the dorsal plate is slightly concave. The ventral sinus is semicircular; its depth is slightly more than half the width. There is no stippled collar, but the anterior margin is slightly thickened, thus forming a faint, bead-like line around the opening for the head.

The foot groove is U-shaped, parallel-sided, and rounded anteriorly; its length is about one-third the length of the lorica. The posterior end of the lorica is bluntly pointed, and projects beyond the point where the sides of the foot groove meet the edge of the ventral plate.

The foot is less than one-fourth the length of the lorica and rather slender; its three joints are of nearly equal length. The toes are a little more than one-fourth the length of the body; they are very slender and taper gradually to acute points. No dorsal sensory pit has been observed on the last foot joint.

Total length, 112 μ ; length of lorica 86 μ , width 88 μ ; width of anterior margin, 26 μ ; depth of ventral sinus, 15 μ ; length of foot groove, 30 μ , width, 14 μ ; length of foot, 19 μ , of last joint, 7 μ ; length of toes, 24 μ ; depth of body, 36 μ .

This description is from a single specimen collected by Mr. Murray in New Zealand and sent to me by Mr. Rousselet. It seems to be rare, the records by Bryce, Murray, and Montet being all that I have been able to find. It is possible that it may have been confused with *L. triptera*, with which it has a certain general similarity; it is, however, considerably larger and more markedly rhomboid.

21. LEPADELLA TRIPTERA Ehrenberg.

Plate 95, figs. 1-4.

Lepadella triptera EHRENBERG, Abh. Akad. Wiss., Berlin, 1830, p. 71.

Metopidia triptera EHRENBERG, Abh. Akad. Wiss., Berlin, 1830, p. 72; Infusionsth., 1838, p. 478, pl. 59, fig. 12.—HUDSON and GOSSE, Rotifera, 1836, vol. 2, p. 108, pl. 25, fig. 7.—WIERZEJSKI, Rozpr. Akad. Umiejtn., Wydz. Mat.-Przyr., ser. 2, vol. 4, 1893, p. 246.—WEBER, Rev. Suisse Zool., vol. 5, 1898, p. 640, pl. 23, figs. 6-9.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 124.—MONTET, Rev. Suisse Zool., vol. 23, 1915, p. 339.

The outline of the lorica varies from nearly circular to broadly pyriform; its width is about seven-eighths of the length. The dorsal

plate is slightly convex and has an extremely high and very thin median keel, extending the entire length of the lorica. The ventral plate is almost plane. The cross section of the body is triradiate; the lateral portions of the body and the keel are very thin, about one-sixth the width of the lorica. The dorso-ventral depth of the body from the highest point of the keel to the ventral plate is a little more than one-half the length of the lorica.

The width of the anterior margin is about two-fifths of the length of the body. No dorsal sinus is present; the frontal edge of the dorsal plate has a shallow notch between two slightly convex lobes. The ventral sinus is broadly V-shaped and rounded posteriorly. There is no stippled collar or any beadlike reenforcement of the anterior edge.

The foot groove is slightly ovate and about one-third of the length of the lorica; its width is a little more than half the length. The posterior end of the lorica projects as an inconspicuous, obtusely pointed lobe, as wide as the dorsal keel.

The foot is a little less than one-third the length of the lorica and moderately stout; its three joints are of nearly equal length. The toes are slender and slightly decurved; their length is about one-fourth of the length of the body.

Total length, 100 μ (small specimens, 83 μ); length of lorica 75 μ , width 64 μ ; anterior margin, 30 μ ; depth of median dorsal notch, 3 μ , of ventral sinus, 14 μ ; length of foot groove, 25 μ , width, 15 μ ; length of foot, 23 μ ; length of toes, 20 μ ; depth of body, 40 μ .

Lepadella triptera is widely distributed; as it is so small and difficult to find, it is probably more abundant than the published records indicate.

Genus LOPHOCHARIS Ehrenberg.

Lophocharis EHRENBURG, Infusionsth., 1838, p. 458. Type (Monotype), *Lophocharis salpina* (Ehrenberg) = *Lepadella salpina* Ehrenberg.

Oxysterna IROSO, Mon. Zool. Italiano, vol. 21, 1910, p. 303. Type (by original designation), *Oxysterna oxysternum* (Gosse) = *Metopidia oxysternon* Gosse.

As noted in the introduction, the two species included in this genus have usually been referred to *Lepadella* (= *Metopidia*). There is no justification for this, as the genus is a well-marked one and differs in many important characters from the Lepadellids.

The lorica is a very rigid, boxlike structure protecting the body on all sides. It is somewhat rhomboid in cross section and has a prominent dorsal keel, of a height equal to about one-third the dorso-ventral depth of the body, extending the entire length of the lorica. A prominent lateral ridge bifurcates anteriorly and continues to the posterior end of the lorica, curving slightly upward in the region of

the foot opening. Near the middle of the body two inclined transverse ridges on each side originate from the lateral longitudinal ridges and disappear before reaching the dorsal keel. On the ventral surface of the lorica a median ridge, beginning near the anterior sinus, reaches as far as the middle of the body and joins a curved transverse ridge, passing entirely across the ventral plate and joining the lateral ridges.

The anterior opening of the lorica is elongate oval, continued dorsally and ventrally as a fairly deep sinus. The opening for the foot is large and ovate, its edges apparently curving inward, so that the border is rather ill-defined.

The lateral antennae are situated some distance above the lateral longitudinal ridges and immediately behind the posterior pair of transverse dorsal ridges; the sensory setae project through small conical prominences on the lorica.

No material suitable for a detailed study of the corona was available, but as far as may be judged from preserved specimens, it does not differ materially from the type of *Trichotria* (= *Dinocharis*).

The foot is about one-fourth the length of the lorica and decreases considerably in size toward the toes. The posterior segment is well marked, but anterior segments are rather ill-defined; apparently two are present. The toes are stout at the base, and the posterior half is very slender and slightly decurved.

The trophi are malleate, resembling closely the *Euchlanis*-type and differ only in minute details in the two species. Figures 11-13, plate 97, are drawn from *L. oxysternon*. The rami are elongate and triangular; on the upper surface of the right ramus there are three prominent transverse ridges continuing over the inner edge as blunt, knob-like teeth, which interlock with two similar structures on the left ramus. The unci are six-toothed; the right uncus has three strong clavate and three linear teeth, while the left uncus has two clavate and four linear teeth. The clavate teeth on each side rest in the grooves between the transverse ridges on the rami, and all six teeth of one uncus are opposite the interspaces of the other. The fulcrum and manubria offer nothing of special interest.

The genus includes but two species, and while the original descriptions are perfectly clear the two forms have for many years been considered varieties of a single species; the records are consequently so inextricably confused that it is rarely possible to decide positively which animal they refer to. Only such citations as appear with reasonable certainty to be assignable to one or the other species are given in the synonymy.

1. *LOPHOCHARIS SALPINA* (Ehrenberg).

Plate 97, figs. 1-5.

Lepadella salpina EHRENBERG, Abh. Akad. Wiss., Berlin (for 1833), 1834, p. 209; Infusionsth., 1838, p. 458, pl. 57, fig. 3.—? TESSIN, Arch. Naturg. Mecklenburg, vol. 43, 1890, p. 162.

Metopidia salpina HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 46, pl. 34, fig. 4.—? JENNINGS, Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 95.—DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 189, text fig.

Metopidia oxysternum ? GLASSCOTT, Sci. Proc. Royal Dublin Soc., n. ser., vol. 8, 1893, p. 75.—BILFINGER, Jahresh. Ver. Naturk. Württemberg, vol. 50, 1894, p. 59.—WEBER, Rev. Suisse Zool., vol. 5, 1898, p. 637; pl. 23, figs. 1-5.

Oxysterna major IROSO, Mon. Zool. Italiano, vol. 21, 1910, p. 304.

Metopidia oxysterna DIEFFENBACH, Süßwasserfauna Deutschlands, pt. 14, 1912, p. 187, text fig.

Lophocharis oxysternum IROSO, Atti R. Ist. Incorr. Napoli, vol. 64 (for 1912), 1913, p. 477, fig. 8.

The lorica of this species is rigid, of very irregularly prismatic form and rhomboid in cross section. It has a prominent dorsal keel which begins at the anterior sinus and continues to the posterior end of the lorica; its height is nearly uniform in the anterior half, about one-third of the dorso-ventral depth of the body, and from there decreases gradually. The cross section is variable; it may be as wide as in figure 5, but is usually narrow and similar to *L. oxysternon*, shown in figure 10. Immediately behind the middle the keel has four transverse folds, those on the right side alternating with identical plications on the left side; they are most prominent at their dorsal extremity and cause the upper edge of the keel to assume a zigzag course, as shown in the dorsal view, figure 3. A lateral rib or ridge begins immediately behind the anterior margin of the lorica and continues to the posterior end; it is bifurcate anteriorly and its course is somewhat irregular, but follows approximately the lateral mid-line of the body, curving upward at the foot opening. Near the middle of the body two transverse ridges, with a slight posterior inclination, start from the lateral ridge and disappear before they reach the dorsal keel. On the ventral surface of the body a median ridge begins near the anterior sinus and reaches as far as the middle of the body, where it joins a curved transverse ridge, which passes entirely across the ventral plate and joins the lateral ridges. From the transverse ridge the ventral plate is rather sharply inclined toward the foot opening, but no groove is present. The dorso-ventral depth of the body is approximately equal to its width, about three-fifths of the length of the lorica.

The anterior margin of the lorica is truncate and provided with a series of denticulations, about 20 in number, decreasing gradually in size from the ventral to the dorsal edge. Neither the general

course nor the spacing is quite constant; frequently the two ventral denticles project slightly beyond the rest, as in figure 1. The dorsal sinus is V-shaped, rounded at the bottom; its depth is one-fifth the length of the lorica. The ventral sinus is semielliptic, and to give additional room for the movements of the head the edges are slightly outcurved; its depth is one-fourth the length of the body.

The foot opening is ovate in outline and pointed posteriorly; its length is one-fourth the length of the lorica and the width about two-thirds of the length. The foot is of moderate length and decreases in size toward the toes; it is apparently three-jointed, but only the posterior segment is well defined. The toes are stout at the base and the posterior half is very slender and slightly decurved; they are one-fifth of the length of the body.

Total length, 175 μ ; length of lorica 135 μ , width 85–90 μ ; dorso-ventral depth, 80–88 μ ; transverse width of anterior margin, 37–42 μ ; depth of dorsal sinus, 17 μ , of ventral sinus, 24 μ ; length of foot opening 38–40 μ , width 25 μ ; length of foot, 32 μ , of last joint, 14 μ ; length of toes, 26 μ .

2. LOPHOCHARIS OXYSTERNON (Gosse).

Plate 97, figs. 6–13.

Metopidia oxysternon GOSSE, Ann. Mag. Nat. Hist., ser. 2, vol. 8, 1851, p. 201.

Metopidia oxysternum HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 107, pl. 25, fig. 8.—SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 327.—VORONKOV, Trudy Hidrobiol Stants. Glubokom Oz., vol. 2, 1907, p. 289.

Oxysterna oxysternum IROSO, Mon. Zool. Italiano, vol. 21, 1910, p. 303.

Lophocharis salpina IROSO, Atti R. Ist. Incorr. Napoli, vol. 64 (for 1912), 1913, p. 477, fig. 7.

The body is inclosed in a firm lorica of irregularly prismatic form and rhomboid cross section. The dorsal keel is very prominent and strongly curved; the height is nearly uniform in the anterior half of its length and from there decreases gradually to the posterior end of the lorica. The sides of the keel are closely approximated, so that it is very narrow in cross section, as shown in figure 10; its height is one-third the dorso-ventral depth of the body; in individual cases a little more. The transverse plications of *L. salpina* are not present in this species. A lateral rib runs the entire length of the lorica; it is bifurcate anteriorly and follows a somewhat irregular course along the lateral mid-line, the posterior end curving slightly upward. From a point near the middle of the body two transverse ridges with a slight posterior inclination branch off from the lateral ridge; they disappear before reaching the dorsal keel. The ventral median ridge begins immediately behind the anterior sinus and joins a transverse ridge crossing the ventral plate near the middle of the body. In front of the foot opening there is a curved ridge, which merges with the lateral ridges at the sides of the foot opening; be-

tween these two ridges there is a deep groove of semicircular cross section passing from side to side of the ventral plate. This groove is narrowest and deepest on the median line, and becomes wider and shallower as it approaches the sides of the body. The dorso-ventral depth of the body varies from one-half to two-thirds of the length.

The anterior margin of the lorica is curved very slightly in its upper portion and quite strongly in the region of the ventral sinus. While it has the appearance of being smooth, it is in reality very minutely denticulate; as this denticulation is quite beyond the possibilities of the halftone process without excessive magnification, it has not been indicated in the illustrations. The dorsal sinus is narrowly V-shaped, slightly rounded posteriorly, and its depth is one-fourth the length of the lorica. The ventral sinus is broadly semielliptic and its edges slightly outcurved, to give the necessary freedom for the head and coronal cilia.

The foot opening is ovate and pointed posteriorly; the length is one-fourth the length of the lorica and the width about two-thirds of its length. The foot is moderately long and the basal portion quite stout; the posterior segment bearing the toes is slender and well defined; anterior segments are indistinct, but probably two are present. The toes are stout at the base and taper fairly rapidly for one-half their length, ending in slender, acute points; their length is one-fifth the length of the body.

Total length, 160 μ ; length of lorica 120 μ , width 75–80 μ , dorso-ventral depth, 55–70 μ ; transverse width of anterior opening, 32–35 μ ; depth of dorsal sinus, 20 μ , of ventral sinus, 21 μ ; length of foot opening, 34–36 μ , width, 24 μ ; length of foot, 30 μ , of last joint, 12 μ ; length of toes, 24 μ .

The differences between *Lophocharis salpina* and *L. oxysternon* are so slight that one description is almost a repetition of the other. Both are variable to a considerable extent, especially in dorso-ventral dimensions; perhaps *L. oxysternon* is the more variable, at least such are the indications of the material examined. On the other hand, this seems to be by far the more common species and there was consequently a better opportunity to ascertain the limits for this form than for the comparatively rare *L. salpina*, known to the writer from local collections only. The following characteristics only may be depended on as distinctive: For *L. salpina*—(1) The angulate anterior margin with distinct dorsal and ventral sinus, the truncate portion being coarsely denticulate; (2) the transverse plication of the dorsal keel; and (3) the absence of a transverse groove on the ventral plate. For *L. oxysternon*—(1) The rounded anterior margin, merging gradually with the dorsal and ventral sinus, denticulation excessively minute; (2) the absence of transverse plications on the dorsal keel; and (3) the deep transverse groove in front of the foot opening. In all other respects they appear to be identical.

EXPLANATION OF PLATES.

All figures are highly magnified. For actual measurements see text.

PLATE 89.

- FIG. 1. *Lepadella apsidea*, ventral view; page 536.
2. *Lepadella apsidea*, lateral view.
3. *Lepadella apsidea*, cross section of body.
4. *Lepadella ovalis*, ventral view; page 537.
5. *Lepadella ovalis*, ventral view.
6. *Lepadella ovalis*, dorsal view.
7. *Lepadella ovalis*, lateral view.
8. *Lepadella ovalis*, cross section of body.
9. *Lepadella ovalis*, ventral view.
10. *Lepadella ovalis*, dorsal view.

PLATE 90.

- FIG. 1. *Lepadella patella*, ventral view; page 539.
2. *Lepadella patella*, ventral view.
3. *Lepadella patella*, dorsal view.
4. *Lepadella patella*, ventral view.
5. *Lepadella patella*, dorsal view.
6. *Lepadella patella*, dorsal view.
7. *Lepadella patella*, cross section of body.
8. *Lepadella patella*, dorsal view.
9. *Lepadella patella*, ventral view.
10. *Lepadella patella*, lateral view.
11. *Lepadella patella*, cross section of body.
12. *Lepadella patella*, ventral view.

PLATE 91.

- FIG. 1. *Lepadella patella*, male, lateral view; page 534.
2. *Lepadella patella*, male, ventral view.
3. *Metopidia collaris*?, lateral view; page 541.
4. *Metopidia collaris*?, ventral view.
5. *Metopidia collaris*?, cross section of body.
6. *Lepadella bidentata*, ventral view; page 550.
7. *Lepadella latusinus*, lateral view; page 542.
8. *Lepadella latusinus*, ventral view.
9. *Lepadella latusinus*, ventral view.
10. *Lepadella latusinus*, dorsal view.
11. *Lepadella latusinus*, ventral view.
12. *Lepadella latusinus*, cross section of body.

PLATE 92.

- FIG. 1. *Lepadella dactyliseta*, ventral view; page 547.
2. *Lepadella dactyliseta*, lateral view.
3. *Lepadella dactyliseta*, cross section of body.
4. *Lepadella acuminata*, ventral view; page 546.
5. *Lepadella acuminata*, dorsal view.
6. *Lepadella acuminata*, lateral view.
7. *Lepadella acuminata*, cross section of body.

- FIG. 8. *Lepadella acuminata*, ventral view.
 9. *Lepadella cryphaea*, ventral view; page 545.
 10. *Lepadella cryphaea*, dorsal view.
 11. *Lepadella cryphaea*, lateral view.
 12. *Lepadella cryphaea*, cross section of body.
 13. *Lepadella borealis*, ventral view; page 550.
 14. *Lepadella borealis*, dorsal view.
 15. *Lepadella borealis*, lateral view.
 16. *Lepadella borealis*, cross section of body.

PLATE 93.

- FIG. 1. *Lepadella benjamini*, ventral view; page 548.
 2. *Lepadella benjamini*, dorsal view.
 3. *Lepadella benjamini*, lateral view.
 4. *Lepadella benjamini*, cross section of body.
 5. *Lepadella benjamini*, corona, lateral view.
 6. *Lepadella benjamini*, corona, ventral view.
 7. *Lepadella benjamini*, trophi, lateral view.
 8. *Lepadella benjamini*, trophi, ventral view.
 9. *Lepadella amphitropis*, ventral view; page 543.
 10. *Lepadella amphitropis*, dorsal view.
 11. *Lepadella amphitropis*, lateral view.
 12. *Lepadella amphitropis*, cross section of body.
 13. *Lepadella cyrtopus*, ventral view; page 549.
 14. *Lepadella cyrtopus*, dorsal view.
 15. *Lepadella cyrtopus*, lateral view.
 16. *Lepadella cyrtopus*, cross section of body.

PLATE 94.

- FIG. 1. *Lepadella ehrenbergii*, ventral view; page 553.
 2. *Lepadella ehrenbergii*, dorsal view.
 3. *Lepadella ehrenbergii*, lateral view.
 4. *Lepadella ehrenbergii*, cross section of body.
 5. *Lepadella pterygoida*, ventral view; page 554.
 6. *Lepadella pterygoida*, dorsal view.
 7. *Lepadella pterygoida*, lateral view.
 8. *Lepadella pterygoida*, cross section of body.
 9. *Lepadella heterostyla*, ventral view; page 552.
 10. *Lepadella heterostyla*, dorsal view.
 11. *Lepadella heterostyla*, lateral view.
 12. *Lepadella heterostyla*, cross section of body.
 13. *Lepadella heterostyla*, cross section through curved wings.

PLATE 95.

- FIG. 1. *Lepadella triptera*, ventral view; page 560.
 2. *Lepadella triptera*, dorsal view.
 3. *Lepadella triptera*, lateral view.
 4. *Lepadella triptera*, cross section of body.
 5. *Lepadella quinquecostata*, ventral view; page 544.
 6. *Lepadella quinquecostata*, dorsal view.
 7. *Lepadella quinquecostata*, lateral view.
 8. *Lepadella quinquecostata*, cross section of body.
 9. *Lepadella imbricata*, ventral view; page 556.

- FIG. 10. *Lepadella imbricata*, lateral view.
11. *Lepadella imbricata*, cross section of body.
12. *Lepadella rhomboides*, ventral view; page 557.
13. *Lepadella rhomboides*, dorsal view.
14. *Lepadella rhomboides*, lateral view.
15. *Lepadella rhomboides*, cross section of body.

PLATE 96.

- FIG. 1. *Lepadella rhomboidula*, ventral view; page 559.
2. *Lepadella rhomboidula*, dorsal view.
3. *Lepadella rhomboidula*, lateral view.
4. *Lepadella rhomboidula*, cross section of body.
5. *Lepadella cristata*, ventral view; page 558.
6. *Lepadella cristata*, dorsal view.
7. *Lepadella cristata*, lateral view.
8. *Lepadella cristata*, lateral view.
9. *Lepadella cristata*, lateral view.
10. *Lepadella cristata*, lateral view.
11. *Lepadella cristata*, lateral view.
12. *Lepadella cristata*, cross section of body.

PLATE 97.

- FIG. 1. *Lophocharis salpina*, lateral view; page 563.
2. *Lophocharis salpina*, lateral view.
3. *Lophocharis salpina*, dorsal view.
4. *Lophocharis salpina*, ventral view.
5. *Lophocharis salpina*, cross section of body.
6. *Lophocharis oxysternon*, lateral view; page 564.
7. *Lophocharis oxysternon*, lateral view.
8. *Lophocharis oxysternon*, dorsal view.
9. *Lophocharis oxysternon*, ventral view.
10. *Lophocharis oxysternon*, cross section of body.
11. *Lophocharis oxysternon*, trophi, lateral view.
12. *Lophocharis oxysternon*, trophi, ventral view.
13. *Lophocharis oxysternon*, trophi, frontal view.